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SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

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THE USE OF FREE GRAFTS OF WHOLE THICKNESS SKIN FOR THE RELIEF OF CONTRACTURES[1]

BY JOHN STAIGE DAVIS, M.D., F.A.C.S., BALTIMORE

THE contractures to be considered in this paper are those following burns, injuries, and infections, in which the skin, and often the subcutaneous tissue, have been completely destroyed.[2]

Contractures have always been surgical "bug-bears," and many methods have been suggested and tried for their relief. Multiple incisions through the scar tissue followed by the injection and inunction of fibrolysin has been advocated, but my belief is that fibrolysin has little, if anything, to do with the occasional good result.

Plastic operations of various kinds have been tried with more or less success. The use of pedunculated flaps is especially valuable when a pad of fat is required in addition to the whole thickness of the skin, but this method should be used only in selected cases, as it has its limitations. In some instances, pedunculated flaps from adjacent tissue are almost impossible to get, especially in finger contractures, and also when the contracture is in the midst of scar tissue. It is usually easy to secure sufficient tissue by using flaps from distant parts, but the constrained position necessary in order to utilize these flaps is exceedingly irksome to the patient, and many are unwilling to endure the discomfort.

All the methods of skin grafting have been tried. The small, thin grafts of Reverdin, and the larger grafts of Ollier-Thiersch are not as a rule effective, especially on exposed positions such as the palmar surface of the hand, both on account of the danger of recontracture under the graft, and also because of the instability of the result. "Small deep grafts" while more resistant, are also unsatisfactory for the relief of contractures. On the other hand, the graft of whole thickness skin furnishes a most satisfactory solution of the problem, and I thought it might be worth while to bring the subject to your attention.

TECHNIQUE

Preparation of the area to receive the graft. If possible the part should be thoroughly massaged for some time before operation, as in this way the surrounding tissues are made more movable; the blood supply is improved, and better results are accomplished. All of the scar tissue should be excised if this can be done with safety, but in many instances the entire part is covered with scar, and in these only the contracture should be entirely excised, while the movable scar tissue beyond should be utilized. In contractures of the hand I have found it best at this stage to apply a splint, previously prepared and sterilized. This splint should be padded with thick felt, and be so arranged that the fingers

[2] No detailed case histories will be given in this report, but photographs are included which give an idea of the cases I have studied. In addition to those shown, contractures in other situations have also been relieved by whole thickness grafts, but photographs were not available for lantern slides.

[1] Read before the Southern Surgical and Gynecological Association, White Sulphur Springs, Virginia, December 13, 1916.

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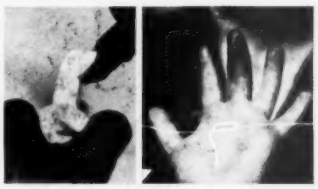


Fig. 1, *A*.

Fig. 1, *B*.

Fig. 1. *A*, Contracture following burn. Duration 9 months. *1*, Before operation; note limit of extension. *2*, After grafting, note perfect extension.

B, Contracture following burn. Duration 7 months. *1*, Before operation; note amount of extension of forefinger and scar in palm. *2*, Result of whole thickness grafting. The first grafting was unsuccessful. The second was completely successful. Note the whole thickness graft on forefinger and palm.

can be held in the desired degree of extension, either by loops of tape, or by cotton glove fingers.

It is of the utmost importance that the raw surface on which the graft is placed be perfectly dry. It is often difficult to check the oozing and in some instances in which the bleeding cannot be stopped it is advisable to wait for a day or two before applying the graft. If the graft is placed on an oozing wound, the chances are that a blood-clot will form beneath it, and this will often seriously interfere with its new blood supply. If the graft is placed on a dry surface, it has the tendency to prevent further oozing, and if any bleeding should subsequently begin, it is usually localized in a comparatively small area, and can escape through the perforations in the graft or between the stitches.

Whole thickness grafts may also be successfully placed on undisturbed, healthy granulations which are level with the skin edges. The grafts should be placed close to the growing edge, and to each other, if more than one is used. Whole thickness grafts placed on dry granulations will adhere to them closely, and no sutures may be necessary. Grafts placed on granulations, at first project above the surrounding skin, but later assume the proper level.

Fig. 2, *A*.

Fig. 2, *B*.

Fig. 2. *A*, Bilateral contracture of both eyelids following burn. Duration 7 years. The patient was unable to close her eyes. When sleeping the eyeballs were turned upward, but the lids were held apart by scar tissue on the forehead and cheeks. *1*, Before operation; showing the extent of closure of the eyelids. *2*, Result of whole thickness grafting, after 20 months. Note the closure of the eyelids.

B, Contracture following chronic ulcer and X-ray burn. Duration 10 years. *1*, Shows ulcer and outline of scar which prevents flexion of thumb. *2*, Result of whole thickness grafting, after 2½ years. The function of the thumb is perfect.

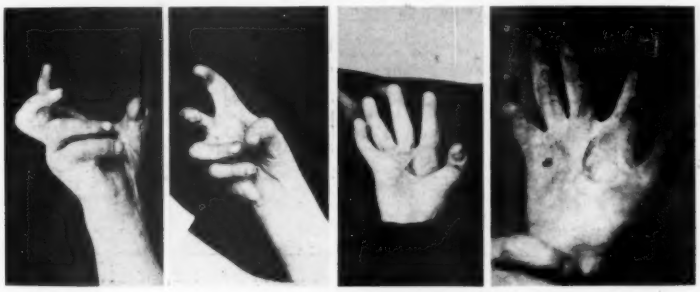


Fig. 3. Contracture following burn. Duration 4 years. *1* and *2* (at left), Before operation. The fingers are extended as much as possible. *3*, Eleven months after whole thickness grafting. *4*, Five years after grafting. The function of the hand is perfect. Note the grafts on the finger, thumb, and palm.

Preparation of the skin from which the graft is taken. Shave the part selected, and wash with green soap and water. Rinse with sterile water. Sponge with ether followed by alcohol. Then rinse with normal salt solution, and dry with a sterile towel. From this point preserve an absolutely dry technique until the graft is in place.

Cutting and placing the graft. Mark out lightly with a scalpel on the skin, an elongated ellipse, bearing in mind that the edges of the wound caused by removal of the graft should be approximated with but little tension. Remove the skin with the underlying fat, down to the fascia or aponeurosis covering the muscle. As soon as the scalpel has penetrated the subcutaneous fat the skin immediately shrinks about two-thirds of its original size transversely, and a little less in its length, and this shrinkage must be planned for.

Wrap the graft in dry gauze until the wound from which it is taken is sutured and dressed. Then trim off all the fat from the graft with curved scissors. Perforate the graft in several places to allow the escape of any blood or secretions which may collect. Fit the graft into the defect, either in one piece or in several pieces depending on the shape of the wound. If one piece can be used, it is advisable to secure it without tension by four cardinal sutures, preferably of horsehair. In some instances a continuous horsehair suture is used to fill in between the cardinal sutures, and in others, a few interrupted sutures. The cardinal sutures should be

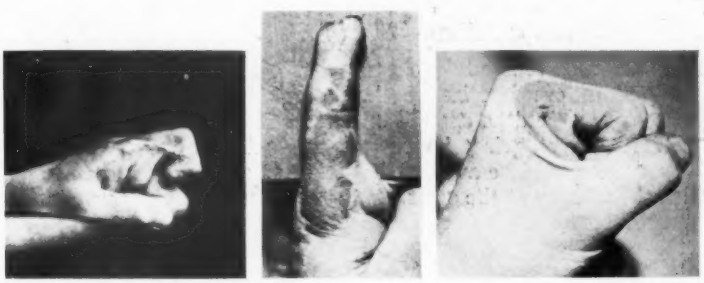


Fig. 4. Contracture following a crush burn between hot rollers. Duration 6 months. *1* (at left), Before operation. Note the limit of extension. *2* and *3*, twenty-one months after whole thickness skin grafting. Note complete extension and flexion. The outline of the graft can be seen. Note slightly roughened and pigmentated skin. The patient, who is a printer, has been able to work at his trade without hindrance since discharge from the hospital.

Fig. 5. Contracture following burn of back of hand. Duration 4 months. *1* (upper left), Before operation. The extent of flexion due to contraction of scar tissue on back of hand. *2* (below) and *3* (upper right), Taken two years later. Result of grafting. Note the size of the graft and the ability to flex the hand. The patient is a presser and has been able to use his iron since operation.

through the full thickness of the graft, but the sutures between should be superficially placed, and should be as close to the edges of the graft and surrounding skin as possible. Occasionally no sutures at all are used as the graft adheres closely to the dry wound, but where no sutures are used it is advisable to secure the graft by means of rubberized mesh. A slight, even pressure should be exerted on the graft to hold it firmly against its base, but too much pressure should be avoided, as it interferes with the vitality of the graft.

The graft should be handled as little as possible, and the necessary handling should be most gentle. All of these points seem trivial, but on them depends the success or failure of this type of graft. A Thiersch graft may be handled with much less consideration and be successfully transplanted.

It is often advised in textbooks to excise the scar tissue in one piece, and after excision to place it as a pattern on the skin and cut the graft by it, but this is not entirely practical, as the majority of scars are irregular in outline, and furthermore the scar itself shrinks after excision, and the graft after cutting shrinks; so little can be gained by this procedure. I consider it essential that the wound from which the graft is taken should be closed at once and not left open as would necessarily follow if an irregular-shaped piece of skin of any considerable size were removed. It is advisable to have the size and shape of the defect in mind when cutting the graft, but it will be found that a piece of whole thickness skin after removal of the fat is very pliable, and can be easily fitted into irregular defects. It is better to have the graft too large than too small, and if the defect is irregular, the graft may after removal be cut into the desired shape, or divided and pieced together. It is, of course, desirable to fill a defect with a single piece of skin, as there are fewer resulting scars, but this is often impossible.

Dressings. Silver foil; dry gauze; moist salt gauze which is kept wet or which is allowed to dry out, are all excellent dressings. Another dressing which I have found useful is a flexible paraffin mixture used by Carrel for another purpose.[1] Any of these may be used with success, but none of them should be used exclusively, as the dressing should be chosen with regard to the surroundings of the wound grafted. For instance, it is more satisfactory to dress a graft used around the eye with moist salt gauze which is kept wet and often changed, as by this means the secretions from the eye are controlled, and there is less danger of infection, etc.

In children under 10 years of age, in addition to the splint in hand and arm contractures, I find that it is always wise to put up the part in a plaster cast. If there are no contra-indications, I do not disturb this cast for at least three weeks, and at the end of this period it will be found that either the graft has taken or, in case of failure, the process of healing has proceeded with the part in good

[1] *Formula.* Paraffin, 52°, 18 grams; paraffin, 40°, 6 grams; beeswax, 2 grams; castor oil, 1 cubic centimeter. Mix. Sterilize in the autoclave and apply at body heat.

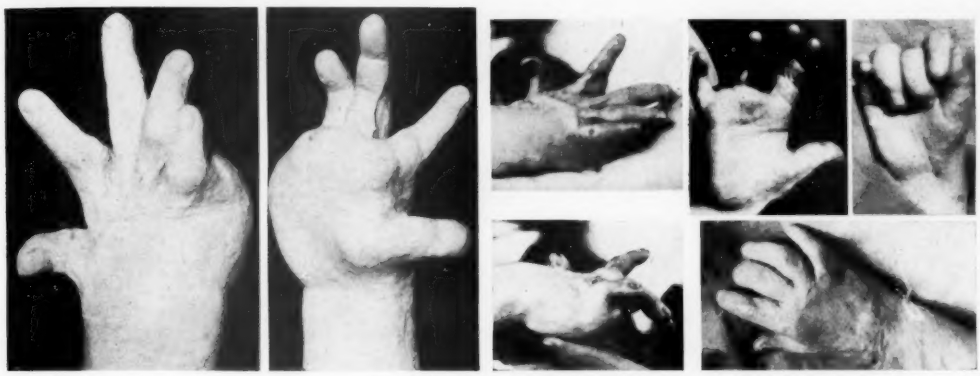


Fig. 6, *1*. Fig. 6, *2*. Fig. 6, *3* (above). Fig. 6, *4* (below). Fig. 6, *5* and *6* (above). Fig. 6, *7* (below).

Fig. 6. Contracture following burn. Duration several months. *1* to *4*, Cast and photographs of hand before operation. Note hyperextension of all fingers. *5* to *7*, Taken 22 months after removal of contracture and transplantation of free grafts of whole thickness skin. Note large size of graft and that it is placed in the midst of scar tissue. Note the difference in flexion before and after operation. The little finger cannot be perfectly flexed, otherwise the patient can make a good fist and has a useful hand.

position. So in either case no time is lost. Another reason for keeping the cast on so long is that it is almost impossible to keep the part in the original position after once removing the dressing. This method of dressing children, also insures immobilization, which is most important.

Except in young children where plaster casts are indicated, it is well to keep the grafted area under constant observation, without disturbing the position of the part, which should be kept immobile until the blood supply is assured.

Anæsthetic. A general anæsthetic is usually necessary in order to remove the contracture, and to prepare the wound for the graft. Advantage is always taken of this anæsthetic to cut the graft, but whole thickness grafts may be easily secured and successfully transplanted after nerve-blocking, or after outlining the area with a local anæsthetic.

Early changes. In whole thickness grafts there may be practically no maceration of the superficial layers, while in some instances, on the other hand, only the corium may remain viable. Now and then an isolated section of a graft will lose its vitality through all its layers, and a patch of granulation tissue will appear. This area should be treated as any other granulating wound.

When the superficial layers are macerated and come away, either as a whole or in part, and the epithelization of the remaining corium is sluggish, it is desirable to scatter over these areas either epithelial scrapings, or small superficial grafts including as far as possible only epithelium. These grafts take readily, and hasten the epithelization. The final result is excellent.

Subsequent changes. The result desired in whole thickness grafting is elasticity, softness, movability, and normal color. Krause says that all of these are obtained in a third of full takes, although the same technique is used in all. In some instances, a brown, irregular pigmentation may appear, but this is no more frequent than in areas grafted with thin grafts, so need not be particularly considered in cases of contracture where function is more important than appearance. The graft may be cyanotic for some time, due to enlarged blood-vessels; later the surface of a graft may become irregularly shriveled. These changes in no way impair the efficacy of the graft, but must be borne in mind from the cosmetic standpoint and the possibility of these complications explained to the patient.

Histological changes. The histological changes in the healing process of a whole thickness graft are, in general, similar to

Fig. 7. Contracture following electric burn. Duration 10 months. (Case reported in SURGERY, GYNECOLOGY AND OBSTETRICS, November 1907, p. 554.) *1* (upper left), Condition of hand May 1, 1906, before grafting. *2* (upper right), taken 18 months after grafting. *3* (lower left) and *4* (lower right), taken November 15, 1916, 10 years 6½ months after grafting. The graft has been exposed to constant trauma incident to farm work. It has increased in size as the hand has grown larger, and has preserved its own characteristics. Hairs similar to those on the thigh, from which the graft was taken are growing on it. The graft is pigmented and wrinkled, but is soft and movable with the surrounding skin. The functional result is excellent.

those which take place in the healing of an ordinary clean wound. There is an exudation of fibrin from the surface upon which the graft is placed, which fixes the graft firmly in position. This fibrin layer is infiltrated by leucocytes and fibroblasts, and vascular sprouts soon begin to form and penetrate the corium, so that in a comparatively short time the graft is supplied with blood. These new vessels have been demonstrated by the injection method in whole thickness grafts on the third day. As early as the sixth day, a whole thickness graft on a fresh wound will bleed when cut. I have obtained bleeding in 84 hours from a whole thickness graft placed on healthy undisturbed granulations. The graft itself begins to take an active part in the healing process after the third or fourth day, there being marked proliferation of cells into the underlying exudation, and an outgrowth of new epithelial cells from the edges; from the ducts of the sweat glands, and from hair follicles. The elastic tissue of the graft degenerates and is replaced by newly formed tissue which probably develops, at least in part, from the pre-existing elements in the graft itself, as well as from the old fibers in the neighboring deeper tissues. A thin layer of adipose tissue develops under whole thickness grafts denuded of fat in two to three weeks. This is most important, as it prevents to a large extent future contracture and insures movability. The scar tissue beneath the graft continues to grow for several months. The newly grafted area must not be exposed too soon to irritation or trauma. It is difficult to guard against this until the nerve supply is re-established, as for the first few weeks the graft is without sensation. Within four or five weeks sensation begins to be restored to the transplanted skin, which gains tactile sensibility first, then pain, and last temperature sense. The nerve fibers undoubtedly grow in from the periphery, and not from the substratum, this being shown by the border sections always regaining sensation first. If the graft is large the central portion may, in some cases, remain less sensitive for a long time, but usually the sensation is entirely restored in the course of a few months.

Isografts and zoografts. While only autografts have been used in this group of cases, I feel that it will not be out of place to make a short note concerning iso and zoografts.

There is much difference of opinion as to the advisability of utilizing isografts, and many surgeons insist that only autografts should be used. Of course, autografts are more likely to succeed, but I feel convinced that when it is not possible to utilize autografts, that isografts are well worth trying, and that very good, lasting results may be secured if the grafts are obtained and transplanted with the proper technique.

The success or failure of isografts may be dependent on the similarity of blood groups of the host and donor, and a subsequent report will be made on this point.

Many successes have been reported follow-

ing the use of zoo grafts from various animals. My own experience is that these grafts take readily and receive their blood supply as promptly as ordinary grafts. They also have the power of stimulating epithelial growth from the edges when placed on granulating wounds, as do other grafts. However, in every case which has been under my observation, these grafts after doing well, and often when the wound is entirely healed, will suddenly with no apparent cause begin to melt away, and will soon disappear.

Transplantation of hair-bearing skin. In those cases of contracture in which the eyebrow has been destroyed, carefully shaped whole thickness grafts of hairy skin from the pubis, with a thin layer of subcutaneous tissue may be successfully transplanted, and will relieve the contracture, and at the same time form an eyebrow. In transplantation of skin from the pubis the direction of the hair growth should be kept in mind. Hair also grows on grafts taken from the thigh, or from any other hairy region. For this reason it is important to choose carefully the region from which the graft is taken.

REMARKS

In spite of various "best methods" of healing wounds, and even in the hands of careful surgeons, contractures do sometimes occur, and will always continue to occur.

Contractures are more likely to follow in those cases which heal by granulation, because of the greater amount of connective tissue formed in the slow healing process. They are much less likely to occur in cases where the healing is properly assisted by skin grafting or plastic operations.

Contractures are caused by the formation and subsequent shrinkage of scar tissue which replaces the skin and subcutaneous tissue.

Contractures following burns have been most frequent in my series of cases, and then following infection and injury in the order named. I have also had a few cases of congenital contractures of the fingers. The majority of contractures have been on the flexor side. In some cases of long standing there has been subluxation of joints, which complicates the treatment.

In cases where the destruction has been deep, it may be necessary to lengthen the tendons in order to obtain extension, and in one or two cases showing subluxation osteotomy has also been necessary.

When contracture of an eyelid is dealt with, it is seldom possible to remove all the scar, but as in other situations all tension can be relieved. It is advisable to markedly overcorrect in relieving these deformities, as the subsequent shrinkage of the scar, and wrinkling and folding of the skin in this situation has to be taken into consideration.

The skin may be taken from almost any situation where there is sufficient laxity of tissue to admit the suturing of the edges of the wound from which the graft is taken.

Grafts may be cut the whole length of the thigh, and from as wide an area as can be sutured. By using a boomerang-shaped incision a very long and wide area of skin may be secured from the abdominal and chest walls.

Often we find after removing a whole thickness graft that large veins which have not been cut are exposed. It is better to excise these veins, for if this is not done there is quite often after closure a thrombosis of the vein without infection, but with subsequent pain and discomfort.

A graft of whole thickness may be placed successfully in the midst of scar tissue, and accomplish its purpose. The result in these cases being that the graft is more stable than the tissue which surrounds it, and it also follows that the scar becomes more resistant as the tension is relieved.

Gentle massage of the grafted area should be started several weeks after operation, and the manipulation be gradually increased until the graft moves freely with the surrounding skin.

Whole thickness grafts are used comparatively infrequently for the relief of contractures, and many surgeons have never used them, preferring to take a chance with the thin grafts.

The operative procedure in securing thick grafts is undoubtedly much greater than in securing thin grafts, and occasionally the after-care is difficult and tedious, but, on

the other hand, the healing following a successful whole thickness graft is as stable and firm and pliable as the original skin. I believe that the ultimate result will more than justify the time taken, as well as the discomfort experienced by the patient.

CONCLUSION

Contractures causing complete or partial loss of function, and accompanied by hideous and crippling deformities, may be relieved by the use of free grafts of whole thickness skin, and the part restored to its former usefulness.

PULMONARY FAT EMBOLISM—A FREQUENT CAUSE OF POSTOPERATIVE SURGICAL SHOCK[1]

By WAYNE W. BISSELL, M.D. Rochester, Minnesota
From the Mayo Foundation

IT is impossible to review the volumes written concerning the etiology of surgical shock without adding another volume to references already well known to surgeons and practitioners generally. A few references to the literature on fat embolism, however, are quite essential.

Warthin has recorded the effects on the heart and circulation of injections of oil into the heart directly, into the jugular vein, and into a heart compensating for an artificially produced valvular lesion. The injection of oil directly into the right auricle of a dog causes a marked fall in carotid pressure and a marked rise in auricular and jugular pressure. Warthin also states that repeated injections cause large systolic pulsations in the right auricle, steady fall of arterial blood pressure, and gradual rise of pressure in the jugular vein and right auricle. He does not refer to the similarity between these experimental observations and the clinical observations on the circulatory phenomena of surgical shock.

The fall in arterial pressure and the rise in venous pressure is precisely what we know to be the case in instances of so-called surgical shock; the patient literally bleeds to death into his own veins.

Fischer has investigated the capillary circulation of the lungs with special reference to fat embolism. He notes that more than 60 per cent of oil injected intravenously into a rabbit soon lodges in the lungs. He also calls attention to experiments by Reuter, who, under his direction, injected oil into the arch of the aorta. This fat also was found in the lungs. While the experimental technique was admittedly crude in a quantitative way, Reuter demonstrated that 62 to 68 per cent of oil injected intravenously could be recovered from the lungs, and 45 to 53 per cent of oil injected into the arch of the aorta also came to rest in lung capillaries.

Fischer explains the retention of fat in the lungs by the great dilatability of lung capillaries, the absence of tissue pressure about the vessels, and the negative alveolar pressure about the capillaries. When oil is injected into the aorta he explains its accumulation in the lungs by the fact that rabbit arterial pressure is 100 to 120 millimeters mercury; pulmonary arterial pressure, 9 to 12 millimeters; and capillary pressure, 33 millimeters. The pressure in the greater (arterial) circulation forces the oil through the capillaries into the venous circuit where pressure in the right ventricle is insufficient to force it through the lung capillaries. He admits his failure to explain fully the rising blood pressure in the right heart in pulmonary fat embolism. By inflating the lung alveoli with oxygen to a pressure of 20 millimeters mercury, Fischer is unable to force pulmonary fat emboli into the greater circulation. He concludes that a large part of the lung circulation can be occluded without seriously threatening life and that the importance of

[1]Presented before the American Association of Pathologists and Bacteriologists, New York, April 7, 1917.

fat embolism in man may be overestimated; at all events, fat embolism as a cause of death can play a rôle only where the pulmonary infarction is very extensive.

There are other factors to be considered. I have observed astounding amounts of fat in the *venous* blood of persons with broken bones and it is presumable that in lipæmia from any cause the venous blood is rich in fat. This observation would be of lesser importance had not Gauss demonstrated that addition of 10 per cent of olive oil to blood increases its viscosity approximately three times, or expressed in percentages, the addition of 10 per cent of olive oil to normal blood increases its viscosity 200 per cent.[1] It being known that pulmonary fat embolism, both in man and experimentally in animals, causes a decreased arterial pressure and increased venous pressure even to fatal termination, it is reasonable to presume that a venous blood rich in fat would offer additional resistance to passage through capillaries due to its increased viscosity. Certainly, it cannot be denied that in the lung capillaries, where fat is accumulated as by repeated injections, the viscosity of the blood must be greatly increased.

During the past eight months I have observed six instances of fatal postoperative fat embolism in the necropsy service of the Mayo Clinic. Three of these followed breast amputation; one, ventral herniotomy; one, craniotomy for brain tumor; and one, laminectomy for spinal cord tumor.

I record the following three of these deaths because postmortem examination revealed no lesions other than fat embolism which could be interpreted as important in the explanation of the mechanism of death.

CASE 1. (167261.) A hotel clerk, 32 years of age, entered the Mayo Clinic on July 26, 1916, in the service of Dr. H. S. Plummer. He complained that ever since boyhood he had suffered the inconvenience of a large umbilical hernia. In 1913 he sought relief in an operation, but after two months a hernia occurred in the operation scar. He stated that the hernia was growing larger and gradually becoming more painful and tender.

Physical examination revealed a well-muscled, but very obese man, weighing 222 pounds, with a large postoperative ventral hernia. Aside from the hernia he presented no noteworthy clinical abnormalities. On three successive days the twenty-four-hour output of urine was normal and the specimens, while containing a trace of albumin, contained no casts or cells. Fifteen minutes after subcutaneous injection of phenolsulphonephthalein the dye appeared in the urine, and in two hours the kidneys returned 110 cubic centimeters of urine, there being 47 per cent of phthalein in the sample. The average systolic blood-pressure for three days was 133 millimeters mercury, and the diastolic, 86 millimeters. The blood contained 7,400 leucocytes and 80 per cent hæmoglobin. The temperature was always normal.

On August 5, 1916, the operation was performed by Drs. Judd and Masson. A long transverse incision was made across the abdomen, the hernial sac was freed from its surrounding adhesions to the thick layer of subcutaneous fat, and a mass of the great omentum, approximately 15 centimeters in diameter, was removed. On account of a wide diastasis of the rectus muscles, the closure of the sac was made very difficult and during this part of the operation the patient became quite cyanotic, sufficiently so to cause the surgeons considerable alarm. The closure was completed, however, and the patient returned to his bed. He improved during the next twelve hours after proctoclysis and hypodermoclysis. The operation was done toward evening. At its close the pulse was of good quality and the rate was 118 per minute. During the course of the next day the cyanosis persisted and was accompanied by considerable dyspnœa. This cyanosis and dyspnœa partially subsided by the end of the first twenty-four hours and the patient seemed to be on the way to recovery. During the course of the second day, however, the temperature rose gradually to 100.5° F., and late in the evening the patient developed a mild delirium. The delirium grew more intense, and by the morning of the second day was associated with tremor and wild hallucinations of sight and hearing. The temperature gradually rose to 105° F. and with it the pulse rate increased to 140 per minute. Death occurred within forty-eight hours of the operation. During the second day the respiratory rate rose rapidly, breathing was attended with great effort, and there were signs of consolidation of the lobes of the lungs posteriorly (Chart 1).

The patient had offered the history that he had been employed as a bartender and up to three months previous to his appearance for treatment,

[1] PROTOCOL OF EXPERIMENT BY GAUSS

TIME REQUIRED FOR ONE CUBIC CENTIMETER OF FLUID TO PASS THROUGH THE CAPILLARY UNDER CONSTANT PRESSURE OF 70 MILLIMETERS MERCURY AND CONSTANT TEMPERATURE OF 24.5°C.

	Alone Seconds	Plus Olive oil Seconds
Salt solution	33	100
Ascitic fluid	45	130
Human blood serum	57	180
Human blood slightly diluted with citrate solution	160	480

had been a moderately heavy user of alcoholics. Had similar clinical observations been made on a person dead of broken bones it is probable that the clinical diagnosis of fatty embolism would have been made, but with the remote history of alcoholism and physical signs of consolidation of lung lobes associated with a delirium characterized by hallucinations and tremor, the clinical diagnosis of lobar pneumonia and delirium tremens seemed logical.

The following necropsy protocol is presented in some detail to impress surgeons more forcibly with the possible extent of postoperative fat embolism:

This is the body of a very obese white man, apparently about 33 to 35 years of age, weighing well over 200 pounds. Lividity of the face, the neck, the lobes of the ears, and the entire posterior aspect of the body is very marked. Elsewhere the skin of the body possesses the pallor of one dead from hæmorrhage. The umbilicus is missing and at its level there is a recently made laparotomy wound, 28 centimeters long, surgically closed with interrupted silkworm-gut retention sutures and a continuous horsehair skin suture. Body heat is present in an elevated degree, even externally.

Scattered over the skin of the abdomen and thorax, there are a few (eleven in all) bright red petechial hæmorrhages. These hæmorrhages are approximately equal in size, measuring 1 millimeter in diameter. They are to be found only in the skin of the ventral part of the trunk.

On opening the body by the usual midline ventral incision, it is noticeable that in the depths of the herniotomy wound there is a great deal of fluid fat mixed with a small amount of bloody serum. In the removal of the hernial sac an elliptic area, 28 centimeters long and 20 centimeters wide, in the thick subcutaneous fat has been surgically traumatized. The trauma is apparently minimal considering the size and nature of the operation, and there has been no bleeding. The abdominal fat measures 10 centimeters through its thickest portion. A part of the great omentum has been removed by this operation; the remainder contains an enormous amount of fat. Scattered throughout the visceral and parietal peritoneum are many bright red petechial hæmorrhages, the largest of which measure 3 millimeters in diameter. There are no other noteworthy abnormalities in the peritoneum.

There is a small persistent thymus in the upper anterior mediastinum. There are no abnormalities in either pleural cavity or in the pericardial cavity. The great vessels entering the roof of the neck are severed, together with the trachea and œsophagus. The entire thoracic content is reflected downward, the diaphragmatic attachments to the ribs and spine are cut, and the entire trunk is eviscerated except for the contents of the pelvis. By so doing all of the viscera of the trunk can be placed upon a pan across the thighs and examination can then be conducted from behind without removal of organs from their relations to one another, and at the same time, thorough examination of the large venous trunks of the body is made possible.

The lungs are quite similar. Scattered throughout the pleura of both are many bright red and faded dusky-pink petechial hæmorrhages. The dependent portions of both lungs are mottled dusky-slate and dusky-pink color. A necropsy pan is thoroughly cleaned with soap and water and dried with clean dry towels. The right lung is carefully washed with running water and without severing its attachments at the hilum the lower lobe is placed over the freshly cleansed and grease-free pan while the convexity of the lung lobe is cut with a thoroughly cleaned knife blade. Immediately there is an escape of a great amount of fluid blood, and as this blood runs over the dry surface of the pan, an almost incredible amount of fat in the form of oil droplets is visible floating on the surface. The lungs contain not only a great deal of fluid blood but also a great quantity of watery frothy material. The surfaces made by sectioning the lungs are everywhere very hyperæmic. Many areas of consolidation are seen in the lung parenchyma as slightly elevated hyperæmic areas of finely granular appearance.

The fatty tissues are dissected from the inferior vena cava and the pericardial covering of the auricles. The inferior vena cava is greatly distended with blood and, on incising it, many fat droplets are visible on the surface of the escaping blood. The blood in the left auricle also contains countless small oil globules.

In the leptomeninges of the brain, there is a great deal of watery material and a marked engorgement of all the blood-vessels. The cerebrospinal fluid is greatly increased in amount but is perfectly clear and watery.

Aside from these descriptions and the lesions named in the anatomic diagnosis, there are no noteworthy gross abnormalities in this body. The contents of the neck and the floor of the mouth are not removed for examination.

Fresh preparations of the top layer of blood running from the surfaces made by sectioning the lung and allowed to stand in a small bottle during the course of the examination, contain nearly as many fat droplets as red blood-corpuscles.

Anatomic diagnosis. Marked obesity; recently made, unhealed and surgically-repaired large transverse umbilical herniotomy wound; absence of a part of the great omentum; many oil droplets in the blood contained in the lungs, the inferior vena cava, right and left auricle, right ventricle and in the large dural sinuses of the brain; disseminated petechial hæmorrhages in the skin, peritoneum, and visceral pleura (fat embolism); marked engorgement of all the large venous trunks of the body and the right auricular and ventricular chambers of the heart; marked bilateral pulmonary œdema; marked bi-

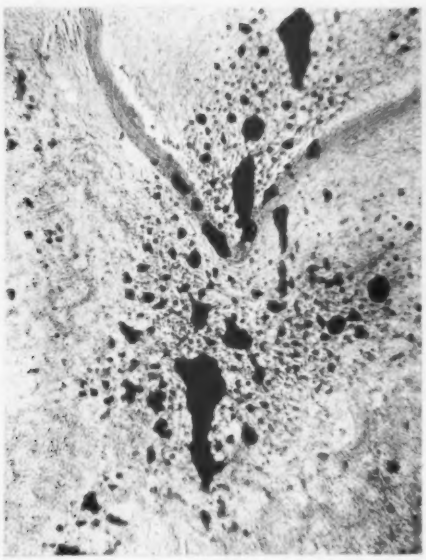


Fig. 1

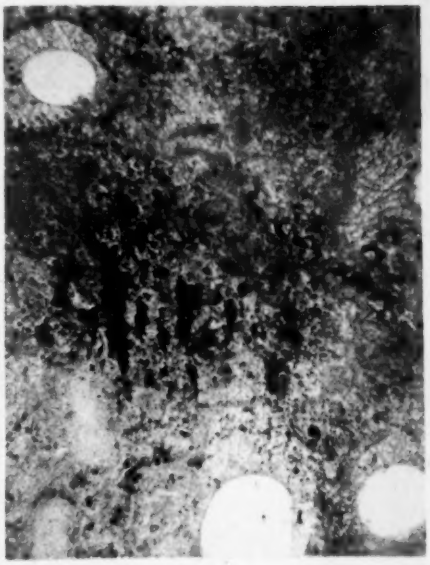


Fig. 2

Fig. 3

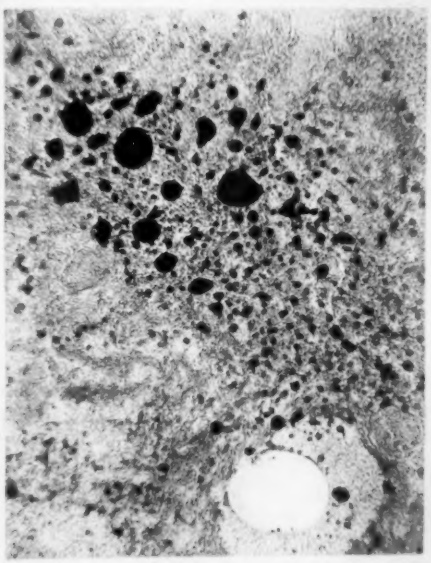


Fig. 4

Plate 1. This illustrates the microscopic distribution of fat in the lungs in the instance of death following umbilical herniotomy. In Fig. 1 fat is seen within the vein as well as in the lung parenchyma. The extensive engorgement of the lungs in a measure explains the clinical diagnosis of lobar pneumonia. Uncounterstained sudan III preparations X50.

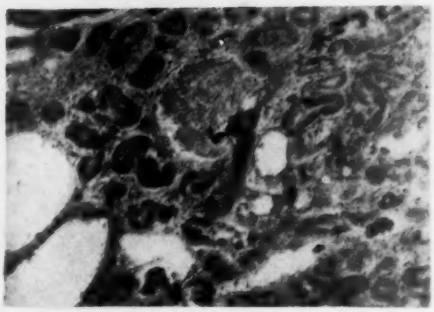


Fig. 1

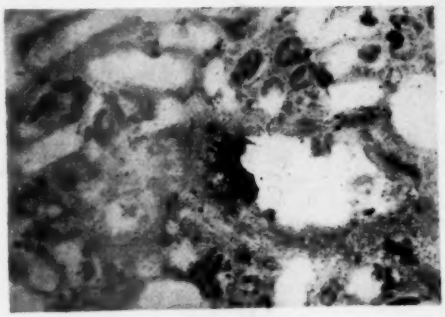


Fig. 2

Fig. 3

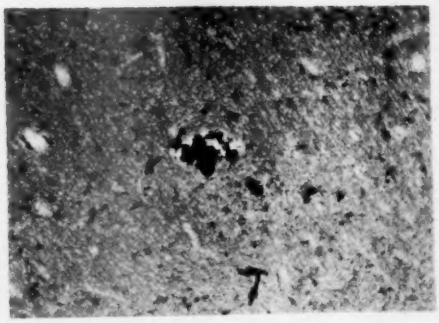


Fig. 4

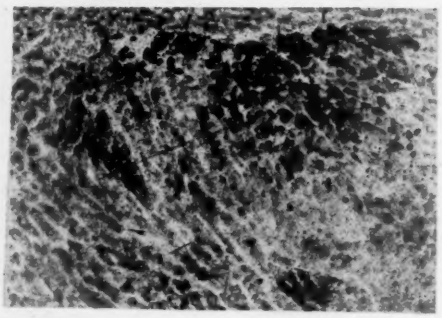


Fig. 5

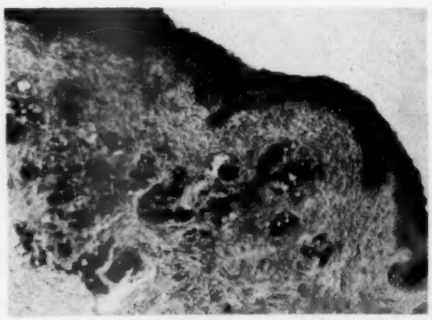


Fig. 6

Plate 2. Dissemination of fat throughout the body following pulmonary fat infarction illustrated in Plate 1. Figs. 1 and 2, are of kidney, 3 and 4 are of brain, 5 is adrenal gland and 6, skin. In considering 3 and 4 it is to be remembered that the clinical cause of death included delirium tremens. Sudan III preparations X50.

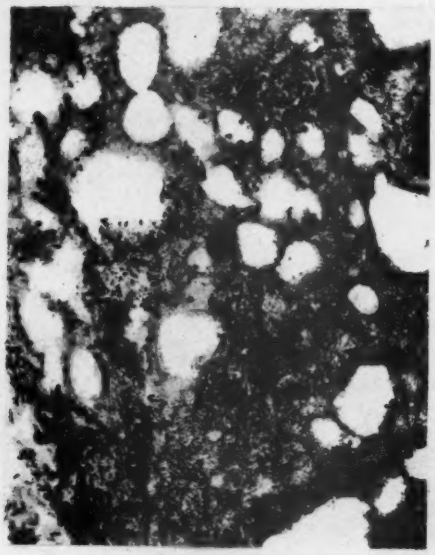


Fig. 1

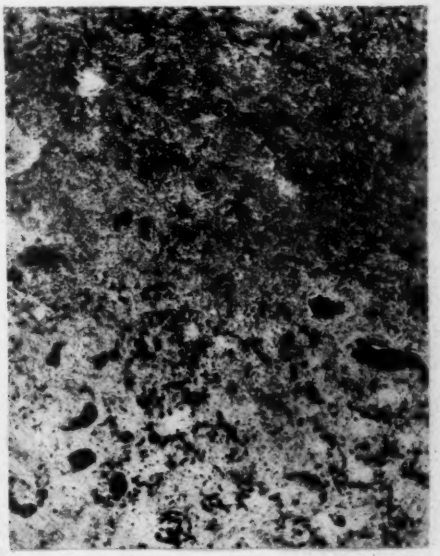


Fig. 2

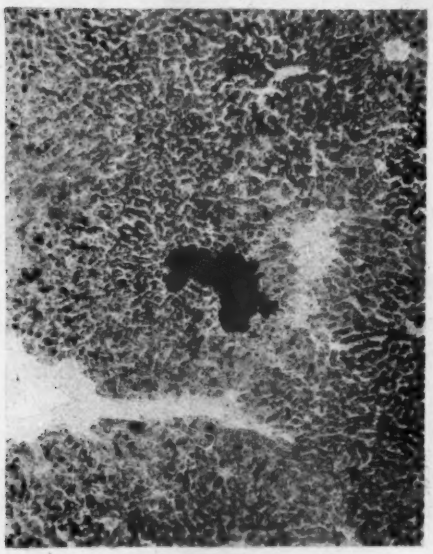


Fig. 3

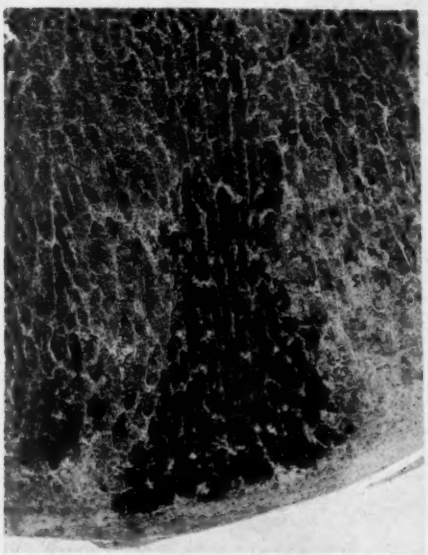


Fig. 4

Plate 3. Figs. 1 and 2 illustrate extensive pulmonary fat embolism following enucleation of both breasts and cholecystectomy in the second case report. Fat infarction is also observed in the liver and adrenal gland. Sudan III preparations X50.

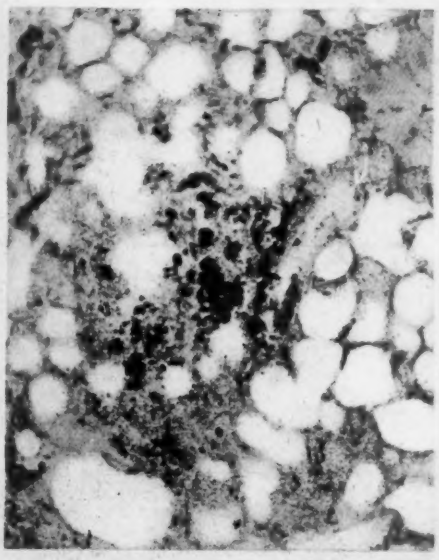


Fig. 1

Fig. 2

Fig. 3

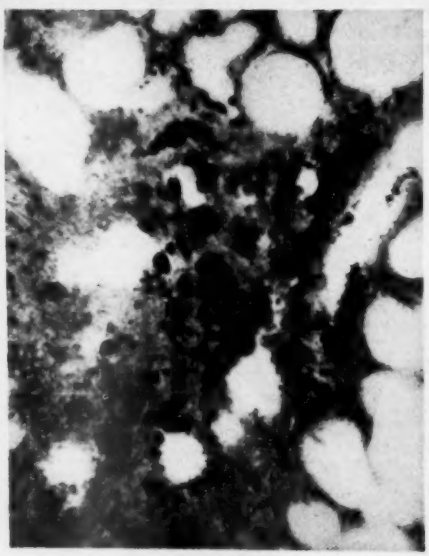


Fig. 4

Plate 4. The death following Halsted amputation of the left breast was clinically supposed to be due to surgical shock. The dissemination of fat in the lungs is extensive. Marked engorgement of parts of the lung is illustrated in Fig. 3. Sudan III preparations X50.

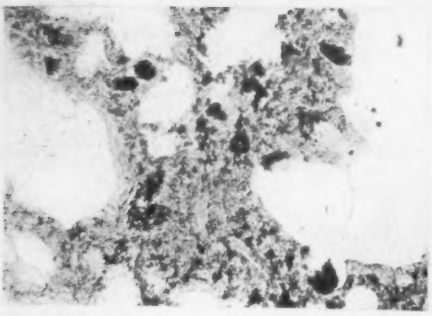


Fig. 1

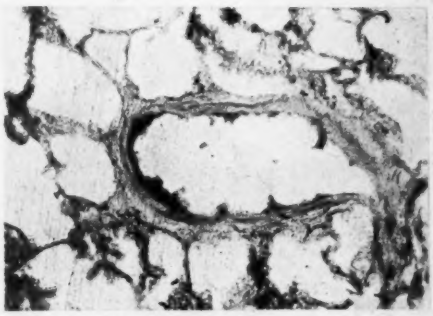


Fig. 2

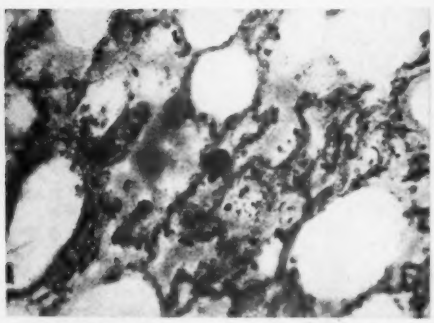


Fig. 3

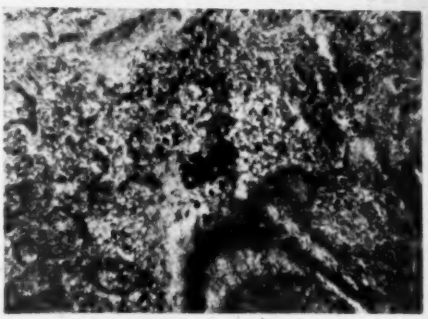


Fig. 4

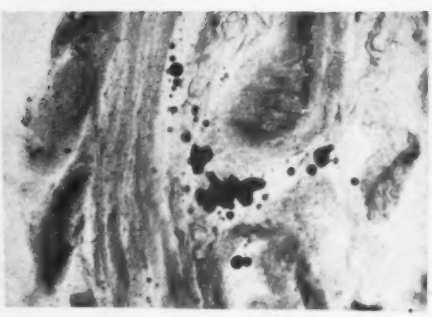


Fig. 5

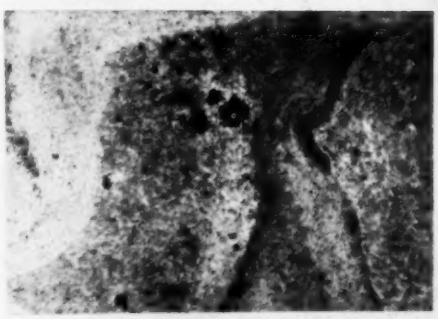


Fig. 6

Plate 5. Additional evidence of extensive pulmonary fat embolism illustrated in Figs. 1 to 4. Fig. 5 is a fat infarct in a coil of small bowel. Fat in the large veins of the spleen is illustrated in Fig. 6. All these illustrations are of sudan III preparations of tissues removed at necropsy following Halsted breast amputation for cancer (Case 3).

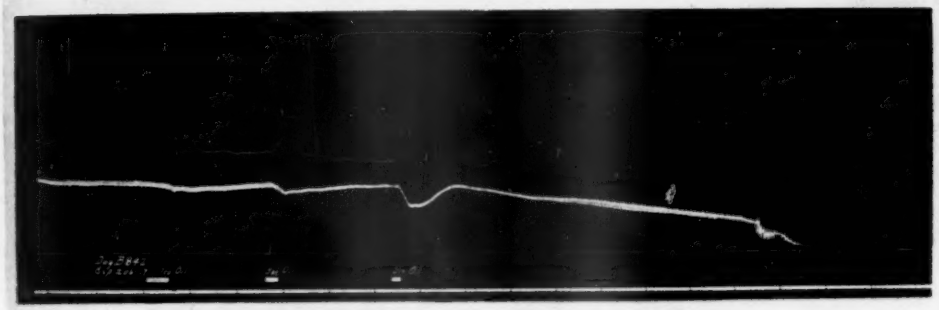


Fig. 1

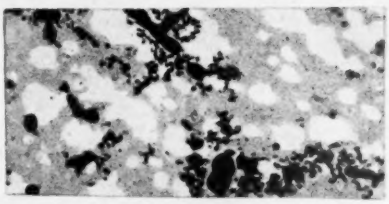


Fig. 2

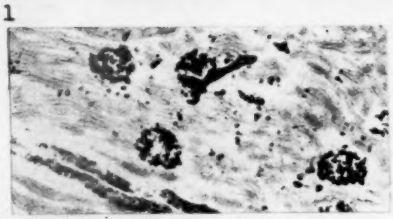
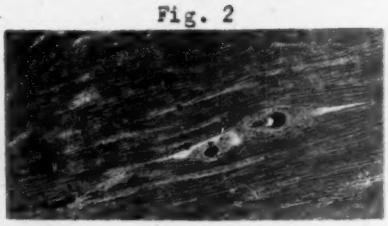


Fig. 3



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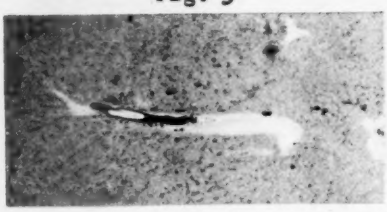

Fig. 5

Fig. 6

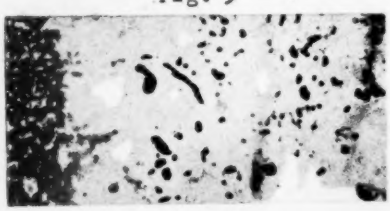

Fig. 7

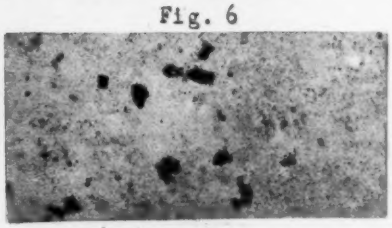

Fig. 8

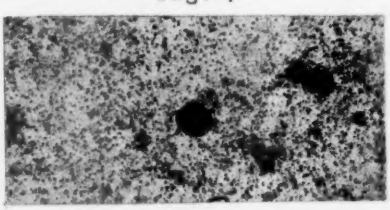

Fig. 9

(See page 17 for legend.)

lateral disseminated bronchopneumonia; marked catarrhal tracheobronchitis; slight hyperplasia of the tracheobronchial lymph-nodes and of the spleen; marked œdema of the brain; marked postmortem lividity of the entire dependent portion of the body and of the root of the neck and lobes of the ears; coalescing petechial hæmorrhages in the mucous lining of the greater antrum of the stomach, the duodenum, the cæcum, and rectum; marked cloudy swelling of the kidneys and myocardium; marked fatty changes in the liver and myocardium; slight varicosity of the superficial veins of the legs.

In the microscopic preparations stained with sudan III, fat emboli are found in the lungs, brain, kidneys, liver, heart-muscle, spleen, adrenals, and skin. Photographs of some of these microscopic preparations accompany this article.

The purpose of this detailed description of necropsy observations and technique is not only to impress the fact that fat embolism is in some instances a fatal complication in laparotomy, but also to outline a technique for the examination of dead bodies which will demonstrate pulmonary fat embolism if it exists. I realize I am presuming that men who examine dead bodies do not know how to demonstrate fat embolism at the necropsy table. This, of course, is not fair to many pathologists, yet the fact remains, that fat embolism is rarely suspected clinically or searched for anatomically unless, perhaps, in instances of persons dying with broken bones.

Plate 6. This graphically presents a typical experiment designed to artifically produce fatal fat embolism. A young dog weighing 7.4 kilos was placed under ether anæsthesia. Apparatus was arranged to simultaneously record the carotid arterial pressure and the pressure in the right auricle. Twenty-three minutes after anæsthesia was started, 7 cubic centimeters of neutral olive oil was injected into the right femoral vein. One and two minutes later additional fractions of 5 cubic centimeters each were injected. In Fig. 1, the upper light line is the record of venous pressure, the heavy line, arterial pressure, the lower line, time in seconds, and the next lines above, signal and base lines respectively. The intravenous injection of 7 cubic centimeters of oil causes a slight but immediate fall in arterial pressure with simultaneous rise in venous. The injection of an additional 5 cubic centimeters accentuates these alterations, while increasing the total oil injected to 17 cubic centimeters causes immediate abrupt rise in venous pressure and fall in arterial. After attempted recovery following the third rise and fall of venous and arterial pressure respectively, rapid exodus occurs. The cannulæ were removed from the carotid artery and right auricle immediately on conclusion of the experiment to make certain the blood pressures recorded were not caused by clotting. Figs. 2 to 9 inclusive illustrate the dissemination of fat throughout the body; sudan III preparations of lung, kidney, heart muscle, liver, medulla, adrenal gland, pancreas and right-auricle-clot in the order named. (X50).

In any interpretation of this experiment it is to be remembered the animal received approximately two fatal doses of oil.

CASE 2. (170641.) A married woman, 41 years of age, entered the the Mayo Clinic on August 26, 1916, in the service of Dr. W. A. Plummer. There were no details in her family, personal or menstrual history bearing on her complaint of right upper abdominal, cramp-like pain. She stated that since the birth of her seven-year-old child she had suffered occasional attacks of this abdominal pain which necessitated the use of morphine. The spasms of pain were of sudden onset, usually lasting one-half to two hours and never followed by jaundice. In all, she had suffered five attacks, the last one occurring two weeks previous to this examination. The pains were never associated with eating. They always radiated to the right shoulder blade. She could not recall that she had had fever with these pains. In addition she called attention to a nodule in the right breast which had been growing since spring.

On physical examination she was found to be a rather stout, little woman, weighing 165 pounds. Her general health was apparently excellent. A palpable nodular and cystic condition was present in both breasts and there was distinct tenderness over the gall-bladder area. There were no axillary enlargements. Examination of the urine revealed nothing abnormal. The blood contained 85 per cent hæmoglobin and the systolic blood-pressure was 130 millimeters mercury, diastolic 78 millimeters. Roentgenographic examination of the kidneys, ureters and bladder did not reveal abnormalities. A clinical diagnosis of bilateral fibrocystic mastitis and cholelithiasis was made.

On August 30th, four days after admission, Dr. C. H. Mayo enucleated both breasts by the conservative Warren operation, preserving the skin and nipples. Under the same ether anæsthesia he removed a thick-walled gall-bladder filled with stones. The entire operation consumed but eighty minutes. Recovery from the anæsthetic was normal. Within twenty-four hours the pulse rate rose to 120 per minute and the temperature rose from 97.6° F. to 101°; some dyspnœa and slight cyanosis developed and the patient became stuporous. During the third day the cyanosis increased and delirium followed. Before death the temperature rose to 103.4° and the pulse rate to 136 per minute. The clinical cause of death was given as surgical shock (Chart 2)

Clinically, this death resembled both surgical shock and fat embolism. The rapid, running, easily obliterated pulse resembled shock. The dyspnœa, cyanosis, delirium, and fever resembled fat embolism. Dyspnœa, cyanosis, and delirium, however, are noted also in surgical shock.

The necropsy was conducted four and one-half hours postmortem in the manner outlined in the first case.

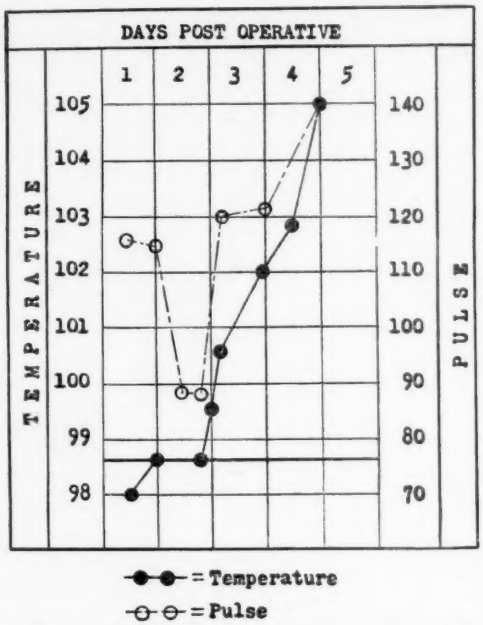

Chart 1. Temperature and pulse curves after operation. Case 1.

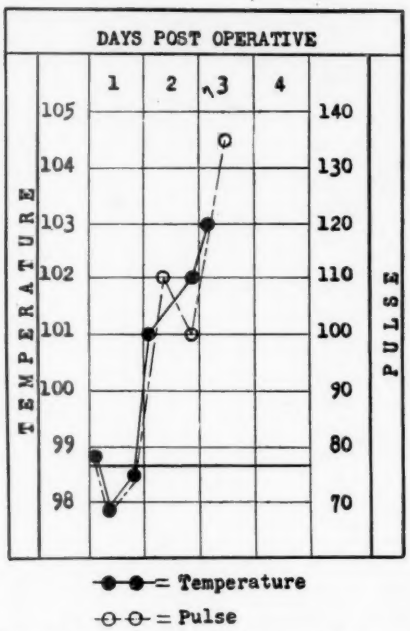

Chart 2. Temperature and pulse curves after operation. Case 2.

Anatomic diagnosis. Recently made surgically repaired and drained wounds inferolateral to each breast and in the right rectus muscle; absence of both breasts and the gall-bladder; moderate obesity; moderate bilateral disseminated fat embolism; fat droplets in the blood expressed from fresh cuts of lung lobes; fat droplets in the fluid material in either pleural cavity, in the tracheobronchial secretions, in the urine, and in the blood-clots of the right auricle; disseminated petechial hæmorrhages throughout the lining of the small bowel and in the lining of the greater antrum of the stomach; petechial hæmorrhages in the mucous lining of the pelvis of the left kidney and in the visceral pleura of both lungs, throughout the peritoneum generally, in the trachea and main bronchi, and disseminated throughout the visceral pericardium and the capsule of the liver; marked fatty changes in the liver; corset deformity of the liver and kidneys; slight bilateral hæmohydrothorax; slight amount of fluid and clotted blood in the dependent portions of the peritoneal cavity; remarkable increase in body heat; moderate gas distention of the small bowel; mucohæmotracheobronchitis; marked engorgement of all the large veins of the body and of the chambers of the right side of the heart; marked general visceroptosis; atrophic striæ gravidarum of the skin of the abdomen and thighs.

Case 3. (171631.) The last case report is of a woman 56 years of age entering the Mayo Clinic on September 6, 1916, in the service of Dr. Logan. She complained of a tumor mass in the left breast which had been present for three years, accompanied for two years by a swelling in the left axilla. Her disorder was obviously a carcinoma of the breast with axillary glandular metastases. Physical examination revealed no contra-indications to operation. She weighed 160 pounds which was her normal weight and there was no evidence of distant metastases of the cancer.

On September 9, 1916, Dr. Beckman removed the left breast and axillary glands by Halsted amputation. The operation consumed 75 minutes. The patient recovered from the ether anæsthetic very promptly and her pulse was of good quality. Very soon, however, the pulse rate increased rapidly and the temperature fell below normal. In spite of vigorous stimulation and application of external heat, the temperature continued subnormal and the pulse was very rapid, irregular and difficult to count. There was no evidence of hæmorrhage. This condition endured for ten hours before death. The clinical cause of death was given as surgical shock (Chart 3).

At necropsy the following noteworthy gross lesions were observed:

Anatomic diagnosis. Large, recently made, surgically incised, repaired, and drained wound of the left breast and axilla; absence of the left breast and the left axillary lymph-nodes; slight surgical trauma

to the left axillary vein; moderate bilateral disseminated pulmonary fat embolism; moderate bilateral hypostatic hyperæmia and œdema of the lungs; moderate bilateral hydrothorax; petechial hæmorrhages in the mesentery of the small bowel and in the capsule of the spleen; pinhead-sized petechial hæmorrhages in the skin; moderate obesity; left apical fibrous adhesive pleuritis; moderate general anæmia; marked engorgement of all the large venous trunks of the body; slight chronic diffuse nephritis — slight secondary contraction of the kidneys; marked cloudy swelling of the liver and kidneys; varicosed veins of the legs.

In considering the two deaths following breast amputations, clinically supposed to be due to surgical shock, I would refer the reader to the masterly writings on fat embolism published thirty-three years ago by Dr. Roswell Park. Dr. Park writes as follows:

CASE 11. During the past winter I was present at an operation for the removal of a cancerous breast from an extremely fleshy woman. The operation was made by one well qualified to undertake it, and passed off without anything unusual transpiring, except, perhaps, that it was somewhat prolonged. The gland was imbedded in adipose tissue, and I noted both that venous oozing was free and that the fatty tissue crumbled readily under the sponge, and even seemed to melt down. The operation was begun about half past ten. The lady never became completely conscious, and died comatose about five o'clock, with nearly every symptom that I have detailed above.[1] I am well aware that in this case the trouble may be ascribed to the anæsthetic, and with some reason; and yet, all things considered, I hold that the case can be properly classed as fatal from fat embolism. Unfortunately, autopsy, which might have cleared this all up, was denied.

In concluding this article Dr. Park said:

1. Fat embolism in varying degrees of severity is not an uncommon complication of surgical accidents and operations.

2. *It may be so mild as to be lost sight of in the general condition of shock, or, perhaps, more properly speaking, it is one factor of a condition of prolonged shock.*[2]

3. Our knowledge of the subject will be greatly increased when we appreciate the possibilities of its occurrence and observe our cases more closely, watching for the appearance of fat in the urine, of slight dyspnœa, etc.

4. When prostration and loss of blood have been great, a moderate amount of embolic disturbance of this kind may serve to turn the scales against a patient who would have otherwise recovered.

[1]The symptoms detailed were: Early palor; somnolence; gradually increasing respiratory rate; increasing dyspnœa; weak, rapid, irregular pulse; subnormal temperature at first, but atypical; delirium and coma.

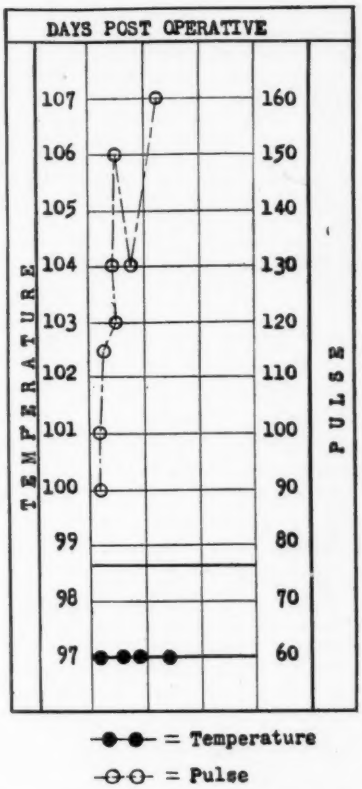

Chart 3. Postoperation temperature and pulse curves typical of surgical shock.

5. By a proper understanding of this subject certain deaths may be explained which otherwise seem inexplicable.

6. Treatment can only be symptomatic, but may accomplish something.

7. *Autopsies should be so conducted as to reveal this condition when present.*[2]

Among more recent and noteworthy physiologic investigations concerning the influence of vasomotor mechanism in producing a condition of surgical shock, the article by Dr. Mann is most interesting. By experimentation on dogs he concludes:

The clinical signs of shock which appear after section of the abdomen and exposure of the viscera are due to a loss of circulatory fluid. This loss of fluid is not dependent upon any primary impair-

[2]Italics are mine.

ment of the medullary vasomotor center and takes place at a point beyond the control of the vasomotor mechanism. The causes for this loss of fluid are apparently the same as those which determine the accumulation of fluid in any other irritated area and produce the signs of inflammation. The nervous system probably plays no greater part in the former case than in the latter. The condition is made grave when the viscera are exposed because of the great vascularity of the tissues involved.

Mann's conclusion that the conditions bringing about shock are beyond control of the vasomotor mechanism is indeed gratifying.

Published with this article, there are addenda by Bloodgood which concern his critical review of a paper by Mann published a year previously. Bloodgood's criticism is of Mann's statement that it is impossible to reduce the anæsthetized animal to a state of shock by any degree of sensory stimulation, providing all hæmorrhage is prevented and the abdomen not opened. Bloodgood's criticism is as follows:

In my experience with operative surgery under general anæsthesia in which the condition of the patient has been most carefully recorded and the blood-pressure changes estimated during the entire operation, I have observed extreme degrees of shock in operations other than on the abdomen, even though there had been no hæmorrhage; for example, during operation for old, badly united fractures of the shaft of the femur. In these cases the only factors which could have produced shock were the painful stripping of the periosteum and the extreme extension of the limb.

He later adds:

Among my records there is an anæsthetic chart which portrays an extreme degree of shock apparently due to an overdose of ether only; then a second chart recorded during a shoulder-girdle amputation in which there was practically no hæmorrhage. The only etiological factors for the shock were ether anæsthesia and trauma.

The reason for citing Park's case is to express the opinion of a leading surgeon of a former time and to compare it with that of a leader in present-day surgery. Had cases been traded about, Park would have had every reason to consider Bloodgood's cases as instances of fat embolism and, on the other hand, Park's case might well have been an instance of surgical shock in Bloodgood's judgment. The real difference in judgment, however, is a fundamental one. The diagnosis of fat embolism, clinically, is based on observations of phenomena produced by distinct, unmistakable lesions grossly demonstrable at necropsy, while the clinical diagnosis of shock is based on observations of signs and symptoms exactly duplicated in pulmonary fat embolism, but so far as I am aware, not satisfactorily explained in the examination of dead bodies *unless hæmorrhage or pulmonary fat embolism is found.*

The instances of surgical shock cited by Dr. Bloodgood can be classified with pulmonary fat embolism and withstand the test of most severe clinical criticism. It is to be remembered that operations on old ununited fractures and amputations generally are exciting causes of fat embolism.

Since this paper has been in progress Porter has published a note concerning fat embolism as a cause of shock. His third conclusion reads: "Fat in the blood stream is known not to be injurious *per se;* its injurious effects are the product of fat embolism."

This conclusion can be contested, at least until we know that the increased viscosity of lipæmic blood is not a factor in the retention of large amounts of fat in lung capillaries and in the venous circuit generally. Porter does not distinguish between pulmonary fat embolism and disseminated fat embolism. He offers no explanation of the mechanism of surgical shock as caused by fat embolism.

The exact mechanism of the death, the mode of entrance of fat into the blood stream, the peculiarities of fat or metabolism, if there are any, which render fat more easily liquefied to enter the blood stream, the relative proportion of fat in the circulating arterial and venous blood, the viscosity of circulating lipæmic blood and the influence of ether anæsthesia on pulmonary fat embolism are some of the more important problems to be undertaken to clarify our understanding of this manner of death and to point the way to rational treatment.

However extensive and varied our investigations may be, there are certain very simple and trustworthy clinical data which demand consideration. The frequency of post-

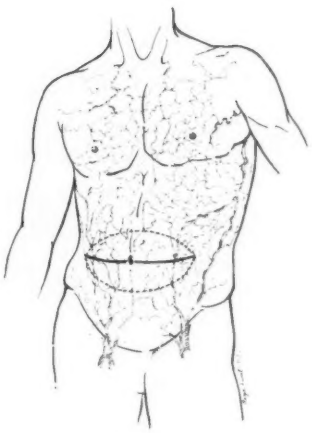

Fig. 1.

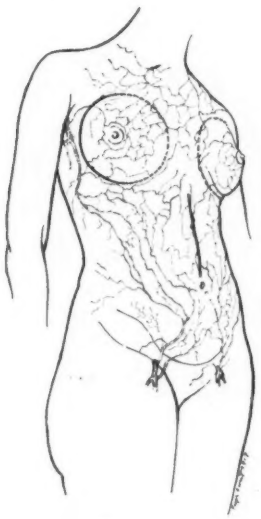

Fig. 2.

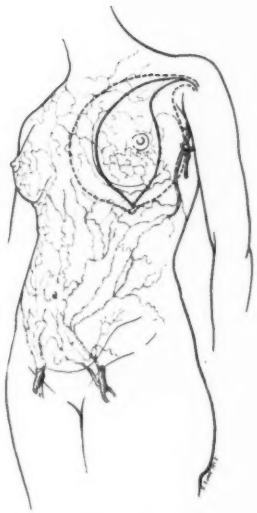

Fig. 3.

Fig. 1. Diagrammatic sketch of the larger superficial veins of the trunk anteriorly. The heavy line indicates the incision for umbilical herniostomy. The dotted lines describe an elliptic area of unavoidable surgical trauma in subcutaneous fat rich in large veins.

Fig. 2. Large areas of injury to subcutaneous fatty tissues and veins in operations for conservative enucleation of breasts. Because of omission of undercutting, it is noticeable that few veins are opened by an incised right rectus laparotomy wound.

Fig. 3. Extensive injury to subcutaneous fatty tissues and veins is caused by radical Halsted amputation of the breast.

operative surgical shock in obese persons as compared to its occurrence in the emaciated or only moderately well-nourished is one of these heretofore unexplained, yet unmistakable, clinical observations.

From his wide experience Dr. W. J. Mayo so firmly believes perfect hæmostasis to be the positive prophylaxis against surgical shock that he frequently criticizes the now common notions of this clinical complex and insists that with perfect hæmostasis there is no shock.

In this connection another simple observation may be cited. In operations in subcutaneous fat, such as the umbilical herniotomy and the breast amputations here reported, it is the common practice for surgeons to ligate the peripheral or bleeding ends of severed veins and leave unligated the central ends which ooze but little blood. With the pressure incident to wound retraction temporary hæmostasis is made on the central ends and the possibility of their opening after closure of the wound is overlooked because experience has taught the surgeon that only the peripheral end of these severed subcutaneous veins is likely to bleed. In all of these wounds, a pool of blood serum and oil globules accumulates after wound closure. It seems reasonable to presume that the gaping mouths of cut veins in such wounds may receive even large quantities of oil material which is conveyed to the lungs through the venous circulation (Figs. 1, 2, and 3).

EXPERIMENTAL

I have repeated the viscosity experiments devised by Gauss and have obtained results entirely similar to his. In addition, it is noticeable that if the dispersion of the oil globules is sufficiently great (the emulsion sufficiently fine) the viscosity of the vehicle is not only not increased, but in some instances the emulsion even seems to be less viscid than the vehicle alone. This is true for normal salt solution, ascites fluid, human blood serum, and citrated blood.

Many animals have been injected intra-

venously with neutral olive oil and the effects on circulation recorded. These experiments have been conducted as Warthin conducted them and similar results have been obtained.

It is so obviously true that oil introduced into the venous circulation causes a marked rise in venous pressure and an associated fall in arterial pressure that our attention should now turn to the mechanism of these alterations. It is to be expected that with fall in arterial pressure and rise in venous pressure there is a marked decrease in perfusion rate of the lung. Experiments designed to measure the perfusion rate in lungs infarcted with fat are now in progress.

CONCLUSIONS

1. Deaths clinically supposed to be due to surgical shock are due, in so far as this experience goes, to pulmonary fat embolism and its attendant blood pressure phenomena.

2. Pulmonary fat embolism causes a lowering of arterial blood-pressure and an elevation of venous blood-pressure which may be sufficient to cause death.

3. Infusions (intravenous) are contra-indicated, because of the increased pressure on the right heart.

4. By simple methods pulmonary fat embolism is easily demonstrated at necropsy.

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OBSERVATIONS ON THE RELATION OF ACIDOSIS TO ANÆSTHESIA

By GUY A. CALDWELL, M.D., and MATHER CLEVELAND, M.D., New York

IN January 1916 with consent and aid of the Surgical Department, we undertook the investigation of the question of acidosis in its relation to the various anæsthetics in use at the Presbyterian Hospital. It was our purpose to determine the degree of acidosis induced in the various surgical processes; what was the difference, if any, between the various anæsthetics in this respect, and what symptoms, if any, might be attributed to acidosis. To that end we have made observations on the blood of about 120 patients together with their acetone and diacetic acid excretion during the period of preparation, operation, and recovery.

SUMMARY OF THE CURRENT LITERATURE

Extensive work has been done of late in connection with the question of acidosis in general, and this has been clearly summarized by Stillman of the Rockefeller Institute, from whom we quote the following abstract:

By acidosis is meant a decreased alkaline reserve of the blood rather than an increased acidity. An accumulation of acids sufficient to create an acid reaction in the blood and tissues is incompatible with life. The alkalinity of the blood is maintained chiefly by the amount of bicarbonate which it contains. This amount may be estimated indirectly in terms of the alveolar carbon dioxide tension of the air in the lungs; directly, by the power of the blood to combine with carbon dioxide.

If acids accumulate in the blood and tissues sufficient to neutralize a portion of the bicarbonate there present, they reduce the alkaline reserve of the blood and tissues below normal. When this occurs, it is accompanied by a diminution in the power of the blood plasma to combine with carbon dioxide, and consequently causes a parallel diminution in the alveolar carbon dioxide. This condition is known as acidosis, although an acid reaction of the blood never

occurs unless *in extremis*. Acidosis, therefore, may be termed as a lessened bicarbonate reserve in the blood and tissues. It may be caused either by an overproduction of acid bodies in metabolism, or by a lessened excretion of these substances.

The need of a method to determine the amount of acid bodies in the medium where the accumulation takes place, is obvious. That medium is the blood. Tests of the urine are valuable only for the excretory phase of acidosis. They may be misleading in that they give no index of the accumulation of these substances in the blood due to overproduction or faulty elimination.

Methods of determining acidosis. Until recently, urinary tests alone have been used as indices of acidosis. These tests have included qualitative determinations for acetone and diacetic acid, quantitative determinations of the acetone bodies, of amomnia, and of total acidity. So long as excretion keeps pace with acid formation, tests of this nature are satisfactory, but when the excretion of acid substances is imperfect, as may occur in diabetes, the elimination cannot keep pace with the production. Therefore, urinary tests may not reveal the degree of acidosis present.

DETERMINING THE ALKALINITY OF BLOOD

There are in use at present a number of direct and indirect methods for the determination of the alkalinity of the blood. Various forms of apparatus have been devised for the determination of the carbon dioxide tension of the alveolar air of the lungs, a favored simple one being the Frederika apparatus. Others have used methods in which the titratable alkalinity of the blood is determined by color indicators, and by hydrogen ionization, but they are all open to many objections, and the errors due to personal factors are large. Former methods for the determination of the carbon dioxide tension of the blood were tedious and cumbersome, but the apparatus which has recently been devised by Van Slyke of the Rockefeller Institute has been found to be a very exact, simple, and direct way by the laboratory and metabolism workers at the Presbyterian Hospital, and accordingly has been chosen by us for making these observations. In dealing with anæsthetics, the question of the methods to be used was limited to observations on the blood and urine, because it is not feasible to obtain alveolar air without the co-operation of the patient.

Technique. The technique used here has been essentially that of Van Slyke as recently reported in the proceedings of the Society of Experimental Medicine and biology.

Ten to 15 cubic centimeters of blood were taken by venous puncture at the times indicated. The blood was received in a centrifuge tube containing sufficient calcium oxalate to prevent clotting, and the tube corked and the blood centrifugated. Three to 4 cubic centimeters of the plasma were pipetted into a 250 cubic centimeter separatory funnel, and saturated to capacity with alveolar carbon dioxide. One cubic centimeter of this plasma was then pipetted into the container of the Van Slyke apparatus and the volumetric readings of the carbon dioxide obtained from the plasma were made. A second reading was made on each specimen of blood for control. These readings were corrected for temperature and barometric pressure, and translated into terms of alveolar carbon dioxide tension according to the tables prepared by Van Slyke in his earlier work[1].

Symptoms of acidosis in relation to carbon dioxide tension. Observations on normal individuals under normal conditions show that by far most of them have a carbon dioxide tension above 40 millimeters, a few, however, with no unusual symptoms, may have a carbon dioxide tension between 40 and 35 millimeters. Hence the lower limit of normal is usually placed at 35 millimeters.

The respiratory center is stimulated by a decreased alkaline reserve, or increased H-ion concentration of the blood. The point at which the response to this stimulus becomes perceptible, is variable in various individuals. Many patients, however, have been observed with readings between 35 and 30 millimeters without perceptible symptoms that might be regarded as caused by decreased alkaline reserve, probably because such patients have a larger reserve lung capacity which enables them to compensate with less apparent effort.

From observations on diabetic and nephritic patients in the medical wards of the Presbyterian Hospital, as well as from pre-

[1] In this paper, the figures represent the carbon dioxide tension in millimeters of mercury of the alveolar air and are employed because acidosis is best understood in those terms by most clinicians. To convert them into figures representing the percentage of bicarbonate carbon dioxide in the blood plasma (the terminology which is being employed in Van Slyke's later work) our figures representing the carbon dioxide tension in millimeters of mercury, should be multiplied by the constant 1.45.

vious observations on acidosis by observers using other methods, the earliest clinical signs of acidosis are vague; irritability, mental torpor, or lessened physical alertness. Such symptoms have been observed with readings between 35 and 30 millimeters. The most characteristic early symptom is hyperpnœa, or dyspnœa of the Kussmaul type, which has been observed with readings between 30 millimeters and 25 millimeters. Drowsiness, headache, vomiting, acetone odor to the breath, the more marked symptoms of the onset of coma, have been observed with readings from 25 to 20 millimeters. Cases with readings below 20 millimeters are usually in coma, but not necessarily so, as is shown by one case cited here, and another seen in the medical wards.

It has been observed also, that a patient may have a real acidosis, as indicated by readings of from 30 to 25 millimeters, without very apparent hyperpnœa, provided he be maintaining that level from day to day, or gradually raising it, but if the alkaline reserve be diminishing from day to day, the hyperpnœa is nearly always apparent.

There are a great many factors concerned in the production of the milder degrees of acidosis, and many of these have been determined by previous workers using various methods (1). It is well known that fasting alone results in a diminution in the alkaline reserve, and causes the appearance of acetone bodies in the urine. But it has been found that while there is a diminution during the first few days of fasting, it is gradually compensated for in the normal individual during the next few days of continued fasting, and will persist at practically normal for several more days of fasting.

Diarrhœa and prolonged fasting (2) have been found to produce more or less diminution of the alkaline reserve, particularly in children where at times symptoms of the more severe grade of acidosis have been observed associated with marked changes in the blood, urine, and alveolar air. Slight changes have been observed also after intense purgation.

Except for the work of Crile, there have been few, if any, reports on the acidosis of anæsthesia, in which observations other than those on the urine were used as criteria of the acidosis (4 and 5). In connection with anæsthesia (4) Crile has found that both ether and nitrous oxide produce immediate increase in the hydrogen ion concentration of the blood; i.e., increased acidity in the blood during anæsthesia and that this acidity is neutralized in an animal in 30 minutes after recovery. He found also that fasting before and after the anæsthetic is an important factor, in that it checks the acid-neutralizing power of the liver. He believes the administration of morphine before operation to be beneficial because less of the anæsthetic is required; hence, the degree of acidosis is lessened (the morphine itself not affecting the acidity of the blood). He discourages its use after operation, however, because "it prolongs the period of neutralization, and in large doses prevents neutralization." Hence, he says, "it would appear that morphine controls the mechanism governing alkalinization or neutralization of the blood." Operative trauma should be minimized because it materially effects the alkalinity, and fear, worry, and anxiety, likewise have some influence, but this can be checked by using bromides before operation.

In our work it was deemed advisable to obtain a normal reading on patients 12 to 24 hours before operation, while they were still on regular diet, and before catharsis had been given. In the earlier part of the work, normal types were chosen to the exclusion of those complicated with infection, new-growths, chronic renal or cardiac disease.

In order to determine the immediate effects of the anæsthesia and operation, readings were made on blood drawn immediately before the anæsthetic was begun, and this compared with readings on a specimen taken immediately at the end of the operation. In a few cases, specimens were taken at short intervals during the operation, readings made, and a curve plotted for the diminishing alkaline reserve.

The period of recovery was studied by taking blood from the same patients 24 hours after operation, and in many cases, several days later, when the temperature was normal and the patient had been taking soft or regular diet.

TABLE I.—A COMPARISON OF CARBON DIOXIDE READING IN THE VARIOUS ANÆSTHETICS

	Average Readings mm. CO^2 in Relation to Preparation and Operation								Recovery of Consciousness Per Cent			Nausea Per Cent			Vomiting Per Cent			Headache Per Cent		
	Reading 24 Hours before Operation. (1)	Reading Immediately before Operation. (2)	Reading Immediately after Operation. (3)	Reading 24 Hours after Operation. (4)	Difference between (1) and (2)	Difference between (2) and (3)	Difference between (3) and (4)	Duration of Anæsthetic (Minutes)	Rate of Dimin. Alk. Per 10 Min. Anæsthetic	Delayed	Early	Immediate	None	Moderate	Severe	None	Moderate	Severe	None	Moderate	Severe
Gas and ether, Bennett, 42 cases	43.7	40.1	35.8	41.6	3.6	4.3	5.8	57	0.6	48	50	2	17	81	2	21	79	0	86	14	0
Ether, open drop, 13 cases	43.7	40.6	35.3	41.7	3.1	5.3	6.4	56	0.9	31	38	31	15	77	8	23	77	0	62	23	15
Gas and oxygen, 14 cases	43.7	40.1	37.3	41.1	3.6	2.8	3.8	44	0.6	8	46	46	64	36	0	64	36	0	64	36	0
Local anæsthetic, 6 cases	41.9	38.2	34.9	39.7	4.7	3.3	4.8	56	0.6	0	0	0	0	0	0	0	0	0	0	0	0
Chloroform cases, 12	40.1	36.9	34.1	36.3	3.2	2.8	2.2	50	0.5	33	42	25	33	66	0	34	66	0.03	83	17	0
Treated cases, 7	41.3	44.7	43.2	42.5	*3.4	1.5	†.7	49	0.3	29	14	57	29	57	14	29	57	14	43	57	0

* Rise as contrasted with fall in untreated case. †Fall as contrasted with rise in untreated case.

Tests for acetone and diacetic acid were made on specimens of urine obtained on the morning of operation, and again on the first specimen voided after operation. The results of these tests, together with their relation to the carbon dioxide tension, are reported in the latter part of this article.

One hundred and twenty-three cases have been thus followed and they have been grouped in the following series, according to the anæsthetic given, and whether or not any treatment for acidosis was used in connection with them.

Anæsthetic	Number of Cases
1. Gas and ether, by the Bennett apparatus	42
2. Gas and oxygen	14
3. Ether, open drop method	13
4. Local anæsthesia	7
5. Chloroform	12
6. Treated cases, various anæsthetics	15
7. Ungrouped cases	20

In connection with the laboratory observations, careful notes were made regarding each patient as to the condition before, during, and after the anæsthetic, the length of the anæsthetic, character of the operation, and mode of the recovery as to nausea vomiting, headache delayed consciousness, postoperative complications, and unusual symptoms. The forms of treatment have varied and in all cases have been controlled by readings before and after the administration to determine the effect on the alkaline reserve of the blood. Sodium bicarbonate was administered in doses of from 20 to 40 grams by mouth during the 12 hours prior to operation, or in the form of 4 per cent solution in normal saline intravenously during and after the anæsthetic, and has been combined with glucose and soda bromide by rectum after operation.

Features of the average curve. With rare exceptions, cases receiving no sodium bicarbonate before their operation, showed a lower carbon dioxide tension in the specimen taken immediately before the anæsthesia, as compared with the specimen taken the day before. This undoubtedly is due in part to their fasting state, dinner the evening before and breakfast on the morning of operation having been omitted; and in part possibly to the preparatory catharsis. How great a part nervous factors play it is difficult to state.

With but three exceptions, all observations showed that the carbon dioxide tension is further diminished during the anæsthetic and operation, varying but slightly in degree with the type of the patient, length and type of anæsthetic used, and the character of the operation.

Despite the fact that the patient's fasting was continued, and that he usually vomited

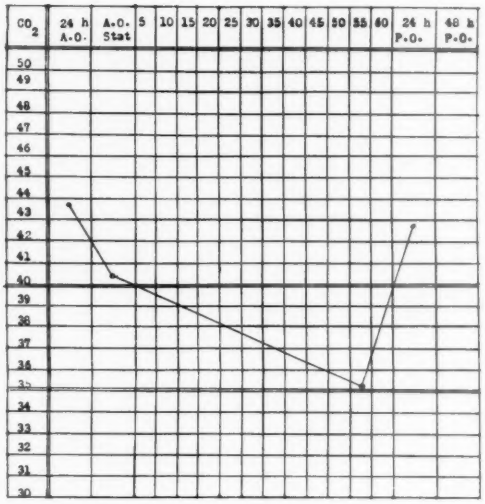

Chart 1. Showing average readings taken 24 hours before operation, immediately before operation, immediately after operation, and 24 hours after operation, in 13 cases of ether-open series.

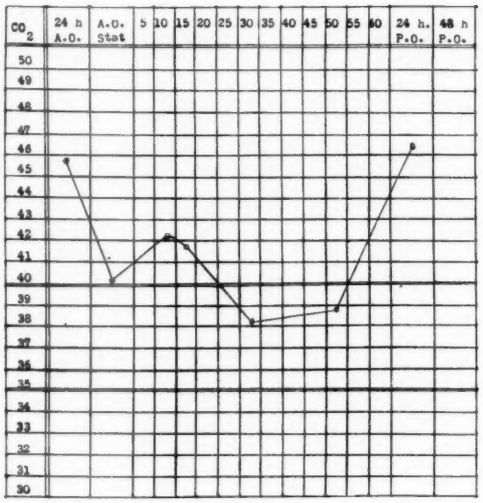

Chart 2. Showing readings taken at various intervals during a 58-minute anæsthetic, gas and ether, Bennett apparatus. Operation, suprapubic cystostomy for removal of vesical calculus.

moderately, the alkaline reserve began to increase within an hour after the operation, and readings of specimens obtained 24 hours after the operation were practically the same as those taken immediately before the operation. By the second day after the operation, readings were practically the same as 24 hours before the operation, and if not, were found to be normal or slightly above, within a day or two after the patient was given a diet.

From the readings obtained on each patient, a graphic chart has been constructed similar to the accompanying ones, on which readings have been charted in relation to the time at which they were taken; i.e., the normal reading 24 hours before operation is placed in the first column to the right of the scale which reads up and down; the reading immediately before the anæsthetic, in the next column to the right, and any reading taken during the anæsthetic, at its proper point, the figures at the top of the chart indicating five-minute periods for a space of one hour. The wider columns at the right on the same scale, allow for readings on the first two days of the postoperative course.

For these charts, a summary has been made in each series, together with the clinical rates and the averages are given in the tables which follow.

The essential facts brought out by these charts 1, 2, 3, and 4 and Table I are:

1. That the average normal reading is between 40.1 and 43.7 millimeters carbon dioxide.
2. That there is a diminution in alkalinity of from 3.1 to 4.7 in the 24 hours prior to operation, probably due to fasting plus purgation.
3. That there is further diminution of from 3.3 to 5.3 during anæsthesias of 44 to 58 minutes.
4. That the diminished alkaline reserve is compensated for largely in the first 24 hours after operation, the rise being 2.2 to 6.5 millimeters carbon dioxide (chloroform being 2.2, somewhat lower than the other averages).
5. That operations under local, as well as those under general, anæsthesia show a diminution in alkaline reserve.
6. That there is but negligible difference between the various types of anæsthesia as to the degree of diminution, but after chloroform there is some delay in the return to normal.
7. That a larger percentage of gas and oxygen cases have no nausea and vomiting than follows other general anæsthetics, although that series shows a rate of diminution equal to that of the gas and ether series.

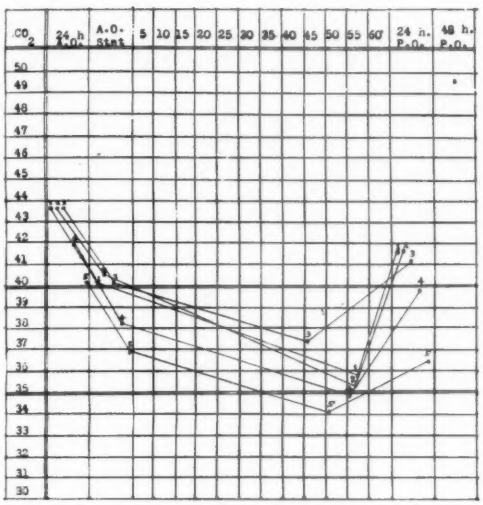

Chart 3. Chart showing averages of readings taken 24 hours before operation, immediately before, immediately after, and 24 hours after operation in connection with (1) gas and ether; (2) ether open; (3) gas and oxygen; (4) local anæsthesia; and (5) chloroform.

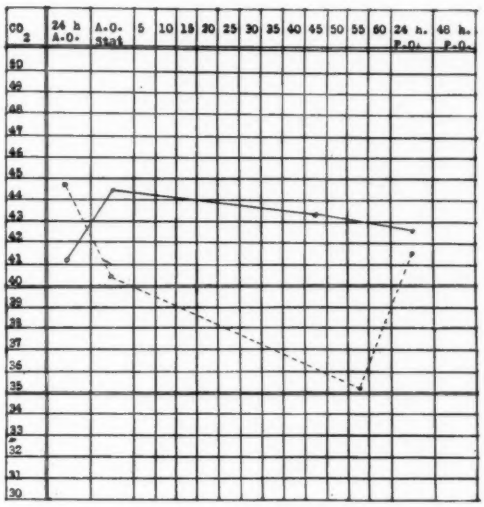

Chart 4. The reversed curve obtained from average readings on 7 cases which had received sodium bicarbonate, 20 to 40 grams, in the 24 hours before operation. The average readings in the ether-open series are charted in dotted lines to show the contrast.

8. That by the administration of sodium bicarbonate by mouth the normal alkaline reserve may be so increased that the usual diminution in the 24 hours preceding operation may be obviated, and instead of a lower reading, a higher reading will be obtained immediately before operation. Furthermore, it reduces the rate of diminution during the anæsthetic by half, but does not necessarily preclude it. In such cases, however, the postoperative compensation, or increase in the alkaline reserve is replaced by a slight diminution, i.e., a return to about the normal level of 24 hours before operation, prior to the administration of sodium bicarbonate.

9. That the postoperative course as to the recovery, nausea, vomiting, and headache, is not appreciably affected by the treatment which has completely compensated for the diminished alkaline reserve that usually occurs in the 24 hours occupied by the preparation and operation.

10. That the diminution in the alkaline reserve below the average normal does not reach the point at which the earliest clinical symptoms are observed to begin.

Further facts gleaned from the summary in relation to—

1. *Infections and postoperative pneumonias*, (7 infections and 3 pneumonias). There were no constant variations from the usual results obtained.

2. *Peritonitis, general.* There were two cases on which no readings were obtained before operation, but with readings taken immediately after operation. One case died the first day after operation of sepsis. The reading after operation was 38.6, and on the following day, shortly before death, was 44.8 millimeters.

The second case of peritonitis survived with the usual long convalescence, accompanied by the development of a subsequent pelvic abscess. The anæsthetic was poorly taken. The reading at the end of the operation was 36.05 millimeters, and 24 hours later was 38.6, 48 hours later was 44.1, and varied thereafter between 42 and 43.7 millimeters while the patient was gradually overcoming the infection, and was 42.5 millimeters after the wound had entirely closed and convalescence established. In other words, the return to normal was not impeded in these cases, by even so extensive an infection as general peritonitis.

3. *Carcinoma.* Readings 24 hours before operation on 3 cases of carcinoma have not varied from normal, being above 40 millimeters, and showed no unusual curve, in relation to the anæsthetic, operation, and recovery.

4. *Operative trauma.* The comparisons are difficult, owing to the variations in the length of the anæsthetics. A rough unit of comparison is obtained by dividing the average length of the anæsthesia, stated in periods of ten minutes, into the difference between the readings obtained immediately before operation and immediately after operation. With this unit of comparison, 12 laparotomies have been

contrasted with 11 extra-abdominal operations (hernias being included in the latter).

The abdominal cases show a rate of diminishing alkalinity of 0.80 millimeters carbon dioxide per 10 minutes, while the extra-abdominal cases show a rate of 0.76 millimeters per 10 minutes.

SPECIAL CASES

The series of treated cases includes three diabetics, two of which were moderately severe, showing marked traces of acid bodies in the urine with large quantities of glucose, and a third who was evidently suffering from marked acidosis, i.e., was very hyperpnœic and drowsy, had a sweetish breath, and had a large carbuncle.

CASE A. Right direct inguinal hernia and double hydrocele. *Treatment.* Fasted for three days, then the urine became sugar-free, and remained sugar-free on standard strict diet for one day before operation. Operation was done on the fifth day, the patient having at the time no glucose in the urine, but faint traces of acetone and diacetic acid. The anæsthetic lasted 1 hour and 37 minutes; recovery was early and accompanied by severe vomiting and nausea during the 12 hours following the operation, but no other unusual symptoms. The urine on the following day, however, contained 7.38 grams of glucose, with very heavy traces of the acid bodies. Although fasting was continued for 6 days after the operation, he continued to excrete diminishing quantities of glucose, the ketonuria became less and less marked, and disappeared when the urine became sugar-free. The blood carbon dioxide on admission was 40.6 millimeters; after 3 days fasting was 37.1 millimeters; immediately before operation, was 35.8 millimeters; at the end of 1½ hour anæsthetic, was 28.3 millimeters; 24 hours later, in marked contrast to the usual case which returns to practically normal (except in the chloroform cases); his reading was 27.8 millimeters. Treatment other than fasting was purposely withheld in order to determine, if possible, what symptoms he might show with readings at that level. He slept most of the time, but could be easily aroused, and really did not appear more drowsy, nor in any way different from the patients who received routine doses of bromides after operation. At the end of 48 hours, however, because the reading was 28.07, he was given an infusion of sodium bicarbonate in normal saline. He had a chill following this, and the reading following it was 40.6 millimeters, but there was no noticeable change in his clinical appearance during the next few days, although his carbon dioxide tension remained at about the normal level. After 8 days of fasting he became sugar-free. His carbohydrates were rapidly increased without the appearance of sugar, and he had an uneventful recovery.

CASE B. Pelvic abscess. 35 grams of glucose in the 24 hour specimen of urine. Marked ketonuria. Blood carbon dioxide 23.1 and 22.8 millimeters on consecutive days without visible hyperpnœa. Patient was cared for by the metabolism department. Fasting with the administration of 10 to 20 grams of sodium chloride by mouth each day. At the end of 6 days, blood carbon dioxide was 42 millimeters. Two days later a posterior colpotomy was done under gas and oxygen. A reading was not obtained immediately before operation, but at the end, was 40.2 millimeters. During the next 24 hours it rose to 47 millimeters (fasting and sodium chloride, 15 grams each day being continued), and at the end of 48 hours was 51 millimeters, and on the seventh day postoperative was 48.3 millimeters.

CASE C. Carbuncle of the back of the neck. Emergency operation. Urine showed very heavy reduction for sugar and marked traces of the acid bodies. Patient was markedly septic, hyperpnœic and had a sweetish breath. Gas and oxygen was given for 10 minuted for the incision and drainage. Blood was taken immediately before and immediately after the administration of the anæsthesia. Patient took the anæsthetic very poorly, his color was bad although he breathed very deeply and rapidly, and was given a high percentage of oxygen. The specimen of blood taken immediately before the anæsthetic read 17.3 millimeters carbon dioxide; that at the end 10.5 millimeters carbon dioxide. Ten hours later, the patient was still showing the exaggerated symptoms enumerated but was not in coma. Reading taken immediately before an infusion of 4 per cent sodium bicarbonate in normal saline, was 9.4 millimeters, 36 hours later the reading was 37.8 millimeters. The symptoms in the meantime disappeared, the breathing became almost normal, and the patient's mental attitude was very much brighter, A second infusion was given, however, and some hours later the blood carbon dioxide was 50.85 millimeters. His further treatment was continued by the metabolism department. He was fasted until sugar-free, his readings averaging 36 millimeters during the fasting period. His course was complicated by the development of numerous abscesses which slowly cleared up, but he was discharged after 53 days with the note that "the patient remained sugar-free on 200 grams of fat, 90 grams of protein, 25 grams of carbohydrate, but with slight ketonuria still present. Blood sugar returned to normal." Clinically, the patient was in good general condition.

RELATION OF ACETONE AND DIACETIC ACID IN THE URINE TO PLASMA BICARBONATE

For a number of years it has been a well-known fact that acetone or diacetic acid, or both, are present in the urine of a certain number of patients before undergoing operation, and to an increased extent, both as to

quantity and frequency after operation. The clinical tests for these two substances are of such simplicity of technique, that often surgeons and laboratory men have been wont to determine the presence of acetone or diacetic acid, and draw their inferences or conclusions as to the so-called state of acidosis from the urinary findings. Since the literature on the subject of postoperative acidosis has been based largely on urinalysis, it seems advisable to review briefly some of the opinions of the workers in this field.

Levison states "When acetone is present before operation, the organism may be able to take care of the anæsthetic without disastrous results, but when diacetic acid is present before operation, the condition is aggravated, and frequently results in acid intoxication." He advocates postponing operation on patients having acid bodies in the urine until they have been eliminated by treatment. This author concludes his paper by advocating glucose by rectum or intravenously after operation, and says: "at times when sodium bicarbonate treatment is persisted in, it appears to accomplish definite results" (6).

Russ states: "The appearance of acetone bodies in the urine indicates a serious perversion of a patient's metabolism, and strongly contra-indicates the administration of a general anæsthetic, until by appropriate treatment the patient becomes able to tolerate the anæsthetic and stand the operation." This same author, in a series of 34 cases, concludes that among the various warning signs of an impending acidosis, including peculiar sweetish breath, unreasoning dread of operation, etc., is the presence of acetone and diacetic acid in the urine. He advocates sodium bicarbonate or sodium citrate by mouth with high carbohydrate diet, "to cause a disappearance of the symptoms and to render the patient a safe subject for anæsthetic and operation" (7).

A more recent contribution to the subject is a report of 138 cases in which Quillian affirms that "the acidosis factor was considered." The laboratory work in this series consists of a "routine preliminary examination for diacetic acid, and whether an acidosis was present or not, sodium bicarbonate and dextrose have been given as a routine preliminary preparation for operation." No tabulated laboratory results are given. Very few of his cases suffered "nausea of any consequence." Only 5 cases had postoperative shock "sufficient to cause anxiety," and above all, there was no mortality. Chronic appendicitis, gynecological repairs, and hernia repairs constituted over 80 per cent of his operations, with a conspicuous lack of any gastro-enterostomies, general peritonitis, brain or spinal cord operations. In this series there was a large percentage of women, who, according to general observations, run a vastly higher percentage of anteoperative acetone and diacetic acid than men. The conclusions which this author says are "naturally deducted," are (1) acidosis has a dominating influence in surgery; (2) by preliminary and postoperative treatment, acidosis may be eliminated; (3)postoperative discomfort and nausea, is greatly diminished by liberal preliminary use of sodium bicarbonate; (4) surgical shock may be avoided by preventing acidosis, and by rapid, careful technique in operative procedures.

The most extensive work done on the subject of acetone and diacetic acid in the urine of patients before and after anæsthesia, had been by Bradner and Reiman. In a series of 214 cases they showed that acetone appeared in 23 per cent of the cases before operation, and in 67 per cent after operation, while diacetic acid appeared in less than 1 per cent of the cases before operation, and in 17 per cent after operation. Their findings, without regard to any theory in regard to acidosis, are summed up as follows: (1) Temperament of the individual, length of time the pre-operative treatment (nothing by mouth, and saline by bowel) had been carried out, appeared to have a slightly positive effect on acetone elimination. (2) Acetone and diacetic acid are eliminated oftener and in larger quantities in women. (3) Surgery alone increased the acid; the gravity of the operation and the severity of the pathology, the amount of obvious shock, had but little bearing on the amount of eliminated acid, and the time of elimination.

In connection with the effect of surgical

TABLE II.—PERCENTAGE OF CASES SHOWING ACETONE AND DIACETIC BEFORE AND AFTER OPERATION, WITH THE VARIOUS ANÆSTHETICS

Anæsthetic	No. Cases	Before and After Operation	Acetone		Diacetic	
			No. Cases	Per Cent	No. Cases	Per Cent
Gas and ether	40	Before	10	25	7	17.5
		After	27	66	26	65
Gas and oxygen	13	Before	4	30	2	15
		After	9	69	8	61
Open ether	14	Before	4	28	1	7
		After	10	71	4	28
Local	7	Before	2	28	1	14
		After	5	71	3	42
Chloroform	12	Before	0	0	0	0
		After	11	91	8	66
Total Average	86	Before	20	23	11	13
		After	62	72	49	56

operation and anæsthesia on the alkaline reserve of the body, we decided to test the urine before and after operation for acetone and diacetic acid. These tests were made along with the routine ante- and postoperative urinalyses. The tests selected were Legal's test for acetone and Arnold's test for diacetic acid, which are simple and unmistakable. The varying intensity of these reactions has been used as a rough estimate of the amount of acetone and diacetic acid, ranging from a very faint trace to a very heavy trace.

These tests have been carried out in 86 cases, which received no alkaline treatment, to determine the effect of various factors on acetone and diacetic acid eliminated. The various anæsthetics, the length of anæsthesia, the gravity of the pathological condition, the severity of the operation, the age and sex of the individual, and the relation of the blood carbon dioxide to the acetone and diacetic acid excretion, were in turn considered.

It was determined that 23 per cent of all patients showed acetone in their urine immediately before operation, and 13 per cent showed diacetic acid. The relatively high percentage before operation is quite probably due in a measure to the withholding of food in the preparation for operation. After operation, 72 per cent of the patients showed acetone, and 56 per cent showed diacetic. The results with the various anæsthetics, including local anæsthesia, held very close to this average, as may be seen in Table II. The chloroform series should, in a measure, be considered apart from the others. It will be noted that none of the patients showed either acetone or diacetic acid before operation. In explanation of this, it can be said that these patients for chloroform, were naturally carefully chosen. More than half of them were men with hernia repair operations. The women consisted of 3 appendicectomy cases, a tracheloplasty, and a lymphadenectomy. None of these patients was at all sick before operation. It is noteworthy that 91 per cent showed acetone postoperatively, and 66 per cent showed diacetic acid postoperatively, although the decrease per 10 minutes in carbon dioxide tension during the operations is the same as in the gas and oxygen series, and less than in the other series. Although the percentage of cases showing acetone and diacetic acid postoperatively is high with chloroform, both of these substances were present in very small traces in every instance. The series is, however, rather small from which to draw any definite conclusions.

The length of operations and anæsthetic apparently had no relation to the presence or amount of acetone and diacetic acid. Some of the longest cases in the gas and ether series, e.g., one of 2 hours and 13 minutes and another of 3 hours, showed no acetone nor diacetic acid in the postoperative urine, while 2 cases of 14 and 15 minutes respectively, showing neither acetone nor diacetic acid before operation, showed both afterwards. The same holds true for the open ether and local anæsthetic series. In the chloroform series, the only case not showing acetone and diacetic acid postoperatively, was 1 hour and 2 minutes, while the shortest case, of 38 minutes, showed both. In the gas and oxygen series, the average elimination of acetone and diacetic acid after operation was less for the cases over 45 minutes than for those under 45 minutes.

The gravity of the pathological condition and the severity of the operation likewise

apparently had no effect on the acetone and diacetic acid elimination. We found that following such an operation as an exploratory craniotomy for brain tumor, a gastro-enterostomy for carcinoma, a nephrotomy, and an exploratory laminectomy, there was no acetone nor diacetic acid, while following a dilatation and curettage, a hernia repair, an osteotomy for hallux valgus, and a clamp and cautery for hæmorrhoids, the profoundest traces of acetone and diacetic acid were noted.

In regard to the relation of blood carbon dioxide to the acetone and diacetic acid eliminated, the following observations were made. We took as an arbitrary standard of alkalinity before operation, 40 millimeters carbon dioxide and 35 millimeters carbon dioxide at the end of operation, and on that basis prepared Table III:

TABLE III.—RELATION OF BLOOD CARBON DIOXIDE TO URINARY ACETONE AND DIACETIC ACID

Before Operation	Acetone		Diacetic Acid	
	Number Cases	Per Cent	Number Cases	Per Cent
Blood CO_2 40 mm. or higher	13	65	7	63
Blood CO_2 under 40 mm.	7	35	4	37
After Operation				
Blood CO_2 35 mm. or higher	35	56	27	57
Blood CO_2 under 35 mm.	27	44	22	43

From this table it is seen that acetone and diacetic acid appear, if anything, more often when the blood carbon dioxide is high than when it is low. If they are present when the blood carbon dioxide is less than 35 millimeters, they are apt to be in heavier traces than when they appear above 35 millimeters. Not infrequently with a reading as low as 30 millimeters, there is no acetone nor diacetic acid. In going carefully over the various anæsthetic series, we find that there is no constant relation between the blood carbon dioxide and the acetone and diacetic acid in urine.

As regards the relation between nausea and vomiting, and the elimination of acetone and diacetic acid, we found that 73 per cent of the cases showing postoperative nausea and vomiting showed acetone and diacetic acid in the urine, while 77 per cent of the cases with no nausea and vomiting, had acetone and diacetic acid.

Age does not seem to appear in any way as a factor in the elimination of acetone and diacetic acid. Sex, however, plays a most important part, as is seen by Table iv. Not only is the percentage of women showing acetone and diacetic acid before and after operation appreciably higher than that of men but the amount of acetone and diacetic acid is almost invariably greater in the women.

TABLE IV.—DISTRIBUTION OF THE CASES ACCORDING TO SEX

	Cases	Men	Women
Gas and ether	40	22	18
Gas and oxygen	13	9	4
Open ether	14	4	10
Chloroform	12	7	5
Local	7	6	1

	Acetone Per Cent						Diacetic Per Cent					
	Gas and Ether	Gas and Oxygen	Open Ether	Chloroform	Local	Total	Gas and Ether	Gas and Oxgen	Open Ether	Chloroform	Local	Total
Before Operation Men	13	33	50	0	16	18	4	22	0	0	20	8
Women	38	25	20	0	100	29	33	0	10	0	0	18
After Operation Men	45	66	100	85	80	62	45	55	0	42	40	41
Women	95	75	60	100	100*	84	88	75	40	100	100	76

*By referring to the legend above it is seen that only one woman was followed under local anæsthesia, thus the impression conveyed by 100% may be erroneous.

In view of the fact that it has been stated that the presence of diacetic acid in the urine is a contra-indication to operation until the condition has been remedied by suitable treatment, a careful study of the 11 cases in our series showing diacetic acid before operation was made. Eleven cases were chosen at random which showed no acetone nor diacetic acid before operation for comparison. Care was taken to have the percentage of women equal in both series.

	Average CO_2 Tension before Operation	Average CO_2 Tension after Operation
Cases with diacetic acid in the ante-operative urine	41.3	34.1
Cases with neither acetone nor diacetic acid in the ante-operative urine	42.8	37.8

The diminution in plasma bicarbonate in the cases with diacetic acid was 7 millimeters, as contrasted with 5 millimeters in those with neither acetone nor diacetic acid, but did not approach a pathological acidosis. In all these cases showing diacetic acid, the condition of the patient under anæsthesia after operation and during convalescence was good.

TREATED CASES

In 13 cases receiving 20 to 40 grams of sodium bicarbonate in the 12 hours prior to operation, the ante-operative urine showed neither acetone nor diacetic acid, while 76 per cent showed acetone postoperatively, and 69 per cent showed diacetic acid. The elimination of acetone and diacetic acid postoperatively with none in the ante-operative urine, was accompanied by a greatly increased alkalinity of the blood up to 53 millimeters or even 59 millimeters in some cases. Whether the failure of acetone and diacetic acid to appear in the ante-operative urine of these cases has any relation to the treatment administered, or is simply a coincidence, we are unable to state.

In 9 cases which received 20 grams of sodium bicarbonate in 500 cubic centimeters of 4 per cent glucose solution immediately after operation, we found the elimination of acetone and diacetic acid, only slightly different from that of the untreated cases. The carbon dioxide tension in this series was well over 40 millimeters and in one case, as high as 54 millimeters in the blood taken after operation. These treated cases followed closely the untreated cases in all respects except the high carbon dioxide tension.

URINALYSIS ON TREATED CASES

		Acetone		Diacetic Acid	
		Number Cases	Per Cent	Number Cases	Per Cent
Cases receiving treatment before operation	Ante operative urine	0	0	0	0
	Post operative urine	10	76	9	69
Cases receiving treatment after operation	Ante operative urine	3	33	2	22
	Post operative urine	5	55	5	55

SUMMARY AND CONCLUSIONS

1. In the average case undergoing operation, not showing glycosuria, very marked ketonuria nor acidæmia before operation, the degree of acidosis induced is negligible, and the choice of anæsthetics, so far as the question of acidosis is concerned, is irrelevant.

2. None of the symptoms observed in the routine postoperative course is due to the slight diminution in alkalinity of the blood and tissues, induced by the preparation, anæsthesia and operation.

3. With the exception of one diabetic patient with obvious severe acidosis before operation, not one case in 120 showed an acidosis, either from a clinical or laboratory standpoint, approaching dangerous proportions.

4. Acetone and diacetic acid occur in the urine of a certain percentage of patients undergoing operations, and in greatly increased percentage and amounts after operations.

5. The presence of acetone and diacetic acid apparently has no relation to the gravity of the operation or the seriousness of the pathological condition, to the length of anæsthesia, nor to postoperative nausea and vomiting.

6. No relation can be determined between the alveolar carbon dioxide tension and the acetone and diacetic acid elimination, neither in the untreated nor carbonate treated cases, the latter having shown acetone and diacetic acid in the presence of high blood alkalinity.

7. Diacetic acid in the urine is not necessarily a contra-indication to operation.

8. Women show larger percentages and amounts of acetone and diacetic acid, both before and after operation, than men.

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RESULTS FOLLOWING THE TREATMENT OF PELVIC INFLAMMATORY LESIONS BY SURGICAL MEASURES[1]

By JOHN G. CLARK, M.D. and CHARLES C. NORRIS, M.D., Philadelphia

ALTHOUGH for several years the general tendency in the treatment of pelvic infections has been progressively conservative, it was owing to Simpson's accurate clinical observations and logical conclusions that the attention of American surgeons has become focused upon the necessity for adopting this vital policy. With absolute rest in the Fowler posture, careful regulation of the gastro-intestinal function, the administration of diuretics, the use of hot douches and of hot or cold applications to the lower abdomen, the temperature declines, the pulse drops to normal, the peritoneal symptoms subside, and the patient gradually becomes free from pain. Under this plan of treatment, fallopian tubes that are greatly enlarged usually diminish in size until they are no longer palpable. If the inflammatory attack is a primary one, and especially if it occurs in young women, in whom acute gonorrhœal infection is so frequently found, it is our policy to permit the patient to return to her home, with the strict injunction, however, that if a subsequent attack occurs, she is to return to the hospital at once. In several of our cases, patients remained free from recurrences and apparently are restored to normal health. Of course such cases are the exception, for in the majority a recurrence will sooner or later take place. When this does occur, the same plan of treatment is pursued as in the primary attack, but when the symptoms again subside operation is urgently advised, acting on the principle that there will be repeated exacerbations of a persistent infection, which will exert a more and more destructive effect on the pelvic tissues with each recurrence.

The rule adopted by us as to the length of time the patient is to be kept in bed is somewhat at variance with that regarded by Simpson as essential. In the average hospital, the ward accommodations are not sufficiently ample to permit these patients to be kept under treatment for an indefinite time. We find it practically impossible to keep such patients in a free bed until the temperature remains normal and is not affected by a bimanual examination or by walking about the ward, and we believe that our statistics warrant us in thus modifying this rule. The underlying principles that serve to guide us, however, are essentially the same as those enunciated by Simpson.

The patient is kept in bed until the acute process subsides and the mass decreases in size or becomes less hyperæsthetic. The temperature must fall to within a degree of normal, and must remain there for at least three to five days before we consider the time for surgical intervention opportune. According to our observations, a patient may remain in the hospital for several days, or even for weeks, before she can be said to have reached the ideal stage insisted upon by Simpson. It is our experience that under so rigid a régimen the patient becomes restless and most importunate in her demands to be permitted to leave the hospital. The complete relief of all symptoms is often the incontrovertible argument advanced against a surgical operation. "Why should I undergo an operation when I am already well?" is a question that is difficult to answer to the patient's satisfaction. We have, therefore, stopped short of the ideal, and have adopted a semiconservative method, which consists in following the waiting policy until one of two conditions is reached. In some cases the infection does not subside, but, instead, the pelvic mass grows larger, until it may reach a considerable size; under these con-

[1] In a previous paper, "Conservative Surgery of the Pelvic Organs in Cases of Pelvic Peritonitis, etc.," Surg., Gynec. & Obst., 1910, pages 298–413, we described the operative methods employed by us. Especial stress was there laid upon the absolute necessity of placing the conserved ovary in a normal anatomic position, carefully preserving the circulation of the structure, and shielding it from every possible surgical traumatism. It is upon the observance of these precautions that the good results of a conservative operation are largely dependent.

ditions we deem surgical intervention advisable. If the mass is easily reached through the vagina, we establish adequate drainage through this avenue, and if the symptoms subside and the patient gets well no further steps are taken. In at least 65 per cent of cases, no further surgical treatment is necessary; in the remainder, however, the pelvic symptoms after the drainage of the abscess may be so persistent as to make an abdominal operation necessary. If the slightest doubt exists as to the possibility of a safe approach through the vagina in reaching the purulent focus we make an abdominal incision and thus effect a complete orientation of the pelvic pathologic lesions. If the small intestine is so situated as to render vaginal drainage hazardous, we then resort reluctantly to the abdominal drain, but, fortunately, this necessity has been very rare. In our experience less than 5 per cent of the most exaggerated pelvic infections are drained through the abdominal incision, the cœliotomy being performed merely as an aid to inspection and palpation, thus rendering it possible to make the vaginal incision safe and adequate for complete drainage purposes. The method of vaginal drainage is a natural one, for when the sitting posture is assumed, purulent matter makes its exit by gravity and is not dependent upon the feeble capillary action of gauze or rubber tissue in siphoning it from a deep pocket.

Under the waiting policy, the great majority of cases undergo gradual subsidence, the inflammatory mass decreases in size, the acute hyperæsthesia largely disappears, the intense cellular infiltration adjacent to the pyogenic focus becomes absorbed, and the connective tissue is restored to a normal pliability. As Saenger has so aptly put it, we are then in a position to remove the débris of the storm without inflicting injury on the adjacent normal or barrier tissue. The only departure, therefore, that we make from Simpson's rule is that of not insisting upon the subsidence of all the local and constitutional symptoms of the primary infection. We believe the safety and advisability of this middle-of-the-road policy are fully sustained by the results achieved in our cases.

TABLE I.—RESULTS OF 308 OPERATIONS FOR INFLAMMATORY DISEASES OF THE PELVIC ORGANS (TABULATED ACCORDING TO PURULENT AND NON-PURULENT LESIONS)

OF A TOTAL OF 308 CASES, 174 HAVE BEEN TRACED

	Presenting Purulent Lesions Regardless of Type of Operation	Presenting Non-purulent Lesions Regardless of Type of Operation	Total Number of Cases
Total number operated upon	137	171	308
Total number of cases traced	78	96	174
Cured	50 (64.1%)	71 (74%)	121 (69.1%)
Improved	19 (24.3%)	23 (24%)	42 (24.1%)
No change	3 (3.8%)	1 (1.04%)	4 (2.3%)
Worse	2 (2.4%)	1 (1.04%)	3 (1.7%)
Deaths* (while in hospital from all causes)	3 (0.97⅓%)	0	3 (0.97⅓%)

*The deaths refer to the total number of surgical cases—308. Actual primary mortality is 0.97⅓ per cent, the fatalities all occurring among the purulent infections. Among the less acute, chronic, and quiescent inflammatory lesions no fatality occurred.

In our endeavor to arrive at a positive opinion as to the relative results following operation in the purulent and non-purulent lesions of the pelvis, we have disregarded the clinical diagnosis, and have classified the conditions according to the microscopic findings reported from our departmental laboratory. Thus there can be no question as to the accuracy of the diagnosis. As will be seen from Table I, the results are decidedly in favor of operation in the non-purulent cases, for of 137 purulent cases operated on, 64 per cent were cured and only 3 died—a fraction over 2 per cent; whereas in the 171 non-purulent cases, 74 per cent were cured and no fatality occurred. Although a complete statistical study of wound healing has not been made, the advantage is nevertheless decidedly in favor of the non-purulent cases. From this study alone it must be conceded that in infections of the fallopian tubes, a conservative waiting policy offers every advantage to the patient. In passing, it may be said that not a single patient has died during the course of this conservative treatment.

In Table II we have made a comparison between a series of 321 cases (Series A) operated upon before 1910 and 195 cases

TABLE II.—COMPARATIVE STATEMENT OF THE RESULTS OF CONSERVATIVE OPERATIONS

Under this heading are classified those cases in which the uterus and one or both ovaries have been conserved, thus permitting menstruation to continue. The majority of these patients have been rendered sterile by bilateral salpingectomy, which includes excision and occlusion, by suture, of the cornual portion of the tube.

	Series A (Before 1910)	Series B[1] (Since 1910)
Total number of cases	321	195
Total number of cases traced	202	90
Cured	137 (67.8%)	58 (64.4%)
Improved	39 (19.3%)	24 (26.6%)
Not improved	12 (5.9%)	3 (3.3%)
Worse	7 (3.4%)	2 (2.2%)
Deaths	7 (2.18%)	3 (1.5%)

[1] In Series B more or less pain, traceable to the conserved ovary occurred in 6 cases; of these, the pain was mild in 4 and severe in 2. In 4 a second operation was required for the removal of ovarian tissue.

(Series B) treated surgically since 1910. The results in both series run closely parallel except as regards the mortality. In our first series the surgical death rate was 2.18 per cent; in the second, 1.5 per cent. This difference may probably be accounted for on the ground that in our second series, greater care was exercised in following the conservative policy. No great stress, however, is laid upon this difference, for so small a ratio between the two may be the result of accidental discrepancies. Since 1910 relatively fewer cases have been subjected to operation, for a larger number have been permitted to leave the hospital without operation, since we are gradually extending our conservatism to the point of withholding surgical intervention until a second attack has occurred. We pursue this policy without hesitation for we are convinced, as the result of a decade of observations, that these patients are subject to almost no risk by deferring operation, since the danger incident to these infections stands in no similar relationship to that of infection of the vermiform appendix. It is also of interest to note that the number of operations for the removal of conserved ovaries has been necessary in only four cases. Of those patients whom we have traced since their discharge from the University Hospital, not one has been operated on in any other hospital. Of the conservative cases, a larger percentage continue to suffer with pelvic ailments than of those cases in which a radical operation has been performed and the ovaries and uterus removed. This is, of course, to be expected, for in almost every conservative operation some pathologic tissue is left behind, and if the infection does not become quiescent and the tissue return to the normal, it will continue to cause more or less painful symptoms. The nearer the patient is to the menopause, the more radical should the operation be, but, unfortunately, the large majority of these infections occur in young women in whom it is so necessary to conserve ovarian tissue.

TABLE III.—COMPARATIVE STATEMENT OF RESULTS OF HYSTERECTOMY

SERIES A
(Operations performed before 1910)

Total number of cases	100
Deaths	6 (6%)

SERIES B
(Operations performed since 1910)

Total number of cases	115
Pyogenic cases (majority chronic)	67
Total number of cases traced	83
Cured	63 (76%)
Improved	18 (21.9%)
Unimproved	1 (1.2%)
Worse	1 (1.2%)
Death	0

	Artificial menopause	Average age
No symptoms	13	34.1
Mild symptoms	52	32.18
Severe symptoms	18	31.9

In Table III we have made a comparison of those cases—115 in all—upon whom a hysterectomy was performed. In this group were represented the more extensive inflammatory lesions. In Series A, the 100 cases operated upon before 1910, the mortality was 6 per cent, whereas in Series B, the 115 operated on since that time, the mortality was nil. This striking difference in results must be again attributed to our insistence upon a careful preparatory treatment. In the first series (A) a greater number were operated upon within a day or two after their admission to the hospital, whereas in the second series (B) almost all were kept under careful observation a few to several days, until the temperature had declined to nearly a normal level and the acute symptoms had subsided.

CONCEPTION IN CONSERVATIVE CASES

Under this heading are placed those cases in which the uterus and one tube and one

ovary (not necessarily on the same side) have been conserved in married women under forty years who have been operated upon at least one year previous to our investigation.

Total number	29	
Births	2	(2 cases, labor normal in both)
Miscarriage	1	(due to a fall.)

SALPINGOTOMIES

Total number	8
Conception	0

In considering the last two groups, cognizance should be taken of the fact that not every marriage is fertile; that of sterile marriages the man is at fault in a definite proportion (33 per cent), and that in many cases the disease is of gonococcal origin, presumably, in the majority in women, the result of marital infection. In such marriages the proportion of sterile husbands is, therefore, greater than among a group of normal men. Moreover, a certain proportion of these patients employed means to prevent conception for some time following operation. Furthermore, possibly five years hence, some of these cases now classed as sterile may become fertile. The number of salpingotomies is too small to permit conclusions to be drawn, but the results tend to confirm our previously expressed opinion regarding the small likelihood of conception occurring following this operation. Among 8 salpingotomies, 7 complained of more or less pain, whereas among 51 bilateral salpingectomies, 41 were cured and 9 improved (1 death).

As the result of our observation of these cases but one conclusion can be reached, and that is, that in all inflammatory cases sterility is the rule, and it is only in the exceptional case that impregnation occurs. In such instances we maintain the hope that, as the result of a conservative operation, the patient may return to fecundity—a hope, however, that is but seldom realized. It is the physiologic effect of the retention of the ovaries rather than the restoration to fecundity, that influences us in favor of conservatism. If, after a careful balancing of the pathologic equation, we are still in doubt as to the advisability of performing total extirpation of the ovarian tissue, we pursue the conservative policy, believing, as we do, that it is better to reoperate radically in the occasional case of failure to relieve the patient, than to pursue a radical extirpative policy from the beginning. Our conviction concerning the vital necessity of preserving ovarian tissue is at variance with that of Graves, who does not attach so much importance to the physiologic influence of the ovary. Certainly our cases have not given us so favorable a view as he holds concerning the comparative freedom from serious nervous symptoms in the younger women.

TABLE IV.—SYMPTOMATOLOGY SUMMARIZED FROM 100 TYPICAL HISTORIES OF PELVIC INFLAMMATORY DISEASE

	Per cent
Pelvic pain	90
Dysmenorrhœa	30
Irregular and too profuse menstruation	42
Leucorrhœa	56
Frequency of or burning on micturition	36
Constipation	30
Nausea or gastric disturbances	26
Headache	14
Backache	30
Nervousness	6
Loss of weight	2
Sterility (as a chief symptom)	2

In Table IV we have taken up in the order of their frequency, the various symptoms from which these patients suffer. It is interesting to note that 42 per cent complain of irregular and too profuse menstruation. This symptom we attribute to the influence of a disordered ovarian function rather than to an endometritis, which so many writers believe is the underlying cause of this functional menstrual disturbance. Endometritis cannot, of course, be ignored as a possible cause for irregular bleeding, but we incline to the view that the disturbing influence chiefly emanates from the irritated ovary.

TABLE V.—ULTIMATE RESULTS BASED UPON THE AGE OF PATIENTS IN INFLAMMATORY CASES

	Years
Average age of all patients	31.18
Cured (all types of abdominal operations)	31+
Improved	27+
Not improved	34+
Worse	31+

According to our preconceived ideas, we have assumed that the curative effect of an operation would increase in exact ratio to the

age of the patient. In this assumption we were apparently mistaken, for in an analysis of our results we find that the age factor plays practically no part. In other words, the older woman is just as likely as is the younger woman to secure an unsatisfactory cure. This applies especially to conservative cases and for this reason, as has previously been stated, in women over thirty years of age, we lean toward a more radical policy when there is any question as to the advisability of performing the more radical operation. In younger women we err more frequently on the side of conservatism, and for very obvious reasons, preferring to resort to a second operation in case of failure of the first. It is also a somewhat noteworthy fact that all the inflammatory cases combined averaged as high as thirty-one years of age. This observation is also opposed to our previous assumption, for prior to our investigation we believed that the large number of much younger women infected by the gonococcus would reduce the average age to less than thirty years. This result of our study is nevertheless somewhat comforting in so far as it indicates that the more radical procedure, which we so strenuously abjure in young women, is really less frequently necessary than we had formerly belived. We feel assured that when the sexual function has been fully established in women past twenty-eight or thirty years of age, the danger of serious neurosis and sexual disturbances developing is much less than in the young unmarried females who have fallen victims to a gonococcal infection. We have usually found that where complete sexual apathy has existed or a serious dyspareunia has developed in married women who had previously been quite normal so far as sexual inclinations were concerned, the sexual function was fully restored even after complete removal of the ovaries and uterus. This is, of course, by no means a constant rule, and is dependent to a large extent upon individual temperament. Given a woman of limited *libido sexualis*, removal of the ovaries almost invariably abrogates all sexual desire. Conversely, in a woman of ardent *libido sexualis*, when the function has been suppressed because of the pain incident to a dyspareunia the result of pelvic inflammatory disturbances, relief of this pain by operation, even when the ovaries and uterus have been removed, may be followed by the return of a strong sexual inclination. The bearing these operations have upon the sexual habits of women is difficult of analysis, for this instinct varies so widely, even in relatively normal women, as to preclude any satisfactory estimate in the subjects of inflammatory infections. We are assured of one fact, however, and that is that in women between eighteen and twenty-five years of age, there is almost invariably a decided atrophy of the vaginal tissues, giving rise to marked diminution in the caliber of the vagina. In women who have not borne children this shrinkage is so great as almost invariably to cause so severe a dyspareunia as to abrogate all sexual relations. Even where there is a considerable relaxation of the pelvic floor in married parous women, owing to this climacteric atrophy we seldom perform a coincident perineal repair, because of the certainty that this additional operative procedure will in many instances lead to serious dyspareunia. In these cases, when ovarian tissue is conserved, even though a hysterectomy has been performed, this sequel seldom follows.

TABLE VI.—COMBINED OPERATIONS IN PELVIC INFLAMMATORY CASES

Total number of cases	308
Combined plastic and abdominal	59
Coincident appendectomy	120
Other combined operations for biliary and other upper abdominal lesions	18

In the presence of a purulent lesion in the pelvis, intra-abdominal manual examination of the organs of the upper abdomen is omitted. Owing to the juxtaposition of the right fallopian tube with the appendix, there is usually a periappendicitis, or appendiceal adhesions. In all such instances the appendix is removed. Even though the symptoms of a lesion in the upper abdomen are marked the hand is not passed up into the area through the incision unless the pelvic inflammatory lesion is absolutely quiescent. If there is an active infection in the pelvis, it is

safer to wait for a more propitious time for performing an operation in the upper abdomen.

As regards surgical intervention in cases of acute pyosalpinx, we feel constrained to record a very decided criticism of a recent article by Coffey[1], "Surgical Treatment of Acute Gonorrhœal Tube Infections with a Quarantine Pack." In this article he reverts to principles long since declared obsolete by the great majority of leading gynecologists and many general surgeons. The placing of a large pack in the pelvis through a long ventral incision is open to so many serious objections that we believe it should be unconditionally condemned. In the first place, Coffey assumes that, as a result of this method, he has actually caused the subsidence and effected the possible cure of a gonorrhœal salpingitis. It has been proved beyond reasonable doubt that the opening of a fallopian tube, in either an acute or a chronic state of inflammation, in the belief that its anatomic structure will be restored to normal, is fallacious. In those pyogenic infections, exclusive of the gonoccocal type, that terminate in an abscess, a free opening with drainage will usually effect a functional cure, for the infecting micro-organism has now run its course, and is generally dead. Not so, however, with the gonococcus, which may remain latent indefinitely, drainage of the abscess merely tiding the patient over an acute exacerbation. It requires no prophetic vision to forecast the result in a hundred cases treated according to Coffey's plan. In a considerable proportion of cases the large drain will inevitably weaken the abdominal wall, and as a sequel a considerable percentage of hernias must follow. Notwithstanding Coffey's contention to the contrary, the presence of so large a foreign body will certainly give rise to innumerable adhesions among the dependent loops of the ileum, thus promoting distressing postoperative symptoms during the earlier convalescence, and will continue as a threatening portent from obstructive possibilities during the more remote periods, after the patient has been discharged from the surgeon's care. The title "quarantine pack" is a misnomer, for it does not quarantine the gonococcal infection, since, from its very nature, the infection is usually localized strictly to the pelvic organs. A general gonorrhœal peritonitis is so rare a condition that it is difficult to collect even in our voluminous surgical literature, a sufficient number of cases from which to draw conclusions as to its true nature. The very paucity of the cases reported in the literature on this subject is a positive argument against Coffey's so-called "quarantine pack." Moreover, the pack does not even free the tubes of the infection. One striking peculiarity of the gonococcus is that, although it is a self-localizing organism, it does not die, but may remain dormant for months or even years, and again spring into active growth. In other words, Noeggerath's theory, "Once infected, always infected," has become a well-established fact. We feel that our statistics and the innumerable papers that may be found in the literature of recent years leave little room for argument in favor of Coffey's position.

The etiology of postoperative adhesions has been most comprehensively investigated, both in the operating room and in experimental laboratories, and it has been proved beyond all doubt that foreign bodies of all kinds, be they guarded as they may, will result in the production of adhesions. Notwithstanding these observations, Coffey asserts that a pack arranged as he suggests will prevent the formation of adhesions. To the contrary, we believe that when he opens a gonorrhœal tube, in which nature is truly quarantining the infectious matter, he has, by means of his drain, established a most effective way for distributing the purulent matter over a fresh abdominal wound; also by capillarity and continuity of surface, the drain conducts the infective material, by means of his pack, to the immediately adjacent peritoneal environs, where it acts as an acute irritant, causing exudation of serum and the formation of plastic lymph—basal conditions for the production of intestinal adhesions.

From our clinical observations in the large series of cases that we have studied, we believe that Coffey's plan is a very

[1] Surg., Gynec. & Obst., 1916, xxii, 228.

hazardous one, reverting to a policy that, if adopted generally, would carry us back to the methods of twenty years ago.

CONCLUSIONS

1. From a study of more than 500 cases in which the postoperative and remote results of surgical intervention in pyogenic infections in the fallopian tubes were considered, we conclude that a course of conservative preparatory treatment decreases mortality, and enhances the chances for securing a good functional restoration of the pelvic organs.

2. In all cases of acute infections of the fallopian tubes, the patient should be kept under observation until the course of the case is defined. (a) In the greatest majority the temperature subsides, the pain disappears, the tubal enlargements decrease to impalpable proportions, and if the attack is a primary one, the patient may be given a respite from operation until a recurrent attack supervenes. Even under these recurrent conditions the conservative policy is again pursued until subsidence takes place a second time, when an abdominal operation is advised, with a view to treating existing conditions to the best possible advantage. Usually both tubes are removed and the ovaries are conserved. (b) If, under the conservative plan, the symptoms do not abate and the tube continues to enlarge, vaginal drainage is instituted, either by direct incision into the cul-de-sac or through the guidance of an abdominal incision.

3. In the purulent lesions of the tube, all operative procedures are attended with a higher mortality and a greater morbidity, whereas under a conservative waiting treatment a patient will seldom die during an acute infection. In our series there was no death. In all hazardous cases the increasing severity of the symptoms and the enlargement of pelvic masses give ample warning, and permit of a simple drainage operation that will tide the patient over the danger.

4. When the acute attack has subsided, the surgeon has the best opportunity for ascertaining, during the course of an operation, the exact degree of involvement of the tissues, and thus he is enabled to select the type of operation best suited to the individual patient.

5. Conservative operative procedures instituted with a view to restoring a closed fallopian tube seldom restore fecundity. Plastic operations upon the fimbriated extremities of the fallopian tubes, with a view to effecting restoration of fecundity are almost invariably failures, and necessitate additional operations. We believe, therefore, that the safer policy usually is to remove the tubes by a wedge-shaped cornual excision in all doubtful cases, thus disregarding any attempt at restoration of fecundity.

6. Hysterosalpingo-oophorectomy in sexually mature women, the subjects of chronic infections of the uterus and adnexa, is followed by a lower mortality and a greater certainty of restoration to health than are possible after conservative operations.

7. Conservative operations employed with a view to preserving ovarian tissue should be limited chiefly to women under thirty years of age.

8. The routine drainage of pus-tubes through an abdominal incision is an unsatisfactory procedure from every standpoint, and should not be resorted to if it can possibly be avoided.

SPINAL ANÆSTHESIA

Its Field, Contra-Indications, Selection

By CARL C. YOUNT, M.D., Panama City, Panama
Resident Surgeon, Hospital Santo Tomas, Panama City, Panama

So much misconception is prevalent in regard to spinal anæsthesia that it has failed to receive its merited position among other valuable anæsthetics. This misconception is largely the result of reports of small series of cases in which this method has been proclaimed with undue enthusiasm or has received unwarranted condemnation. Reports of isolated cases in which the results have been unsatisfactory or disastrous in the hands of those trying the method for the first time have done much to discredit it. Several large series of cases have been reported in the last few years which represent years of experimental and clinical observation of the method, and upon these should be based the true estimate of the value of spinal anæsthesia. The general tendency has been to assume a more conservative attitude in regard to its use and to admit certain limitation and some objectionable features, but practically all agree that it has a distinct field of usefulness. Thanks to Barker, Babcock and others the technique has been developed to a fair degree of perfection but no single definite technique has been uniformly accepted and used, the various clinics using different solutions each requiring a slightly different technique. Familiarity with the different varieties of solution and the technique required for each, and utilizing them in the field to which they are best adapted would bring about more uniformly good results.

During the past seven years spinal anæsthesia has been used in this hospital more than 7000 times. Except during a brief period of experimentation in 1909, when different drugs and solutions of varying specific gravity were being used, we have confined ourselves to the use of stovain in a solution heavier than the cerebrospinal fluid. The technique has been previously described in detail.

The opinion that spinal anæsthesia should not be used extensively by one who is not specially trained in the method has steadily grown with us. In the hands of the novice the percentage of failures and untoward effects is high and danger to life cannot be lost sight of. A comparative study of our early and more recent cases confirms this assertion. We found the percentage of failures for one of us having a large experience to be about 0.8 per cent and that for six different doctors of meager or moderate experience to be 6¼ per cent. The percentage of untoward effects maintain about this same ratio under similar conditions.

Realizing that our technique has not been sufficiently diversified to admit of the widest field of successful applicability of spinal anæsthesia and admitting the possibility of a wider field of usefulness, we offer the following observations on the use of spinal anæsthesia solely from our own experience.

FIELD

We are convinced that spinal anæsthesia, in the hands of one trained in the method has a field in which it is in almost every respect the anæsthetic of choice, i.e., for operations on the lower rectum and anus, perineum, all genito-urinary operations except those involving the ureters and kidneys, all varieties of hernia except those occurring above the umbilicus; appendectomy and all operations on the lower extremities. In this group of operations the dose required is small and the drug is confined to the lower part of the subarachnoid space, thus rendering collapse and respiratory paralysis, the only really dangerous complications, practically impossible. The unfavorable postoperative effects usually seen following the use of spinal anæsthesia for operations on higher regions of the body are so infrequent as to be almost negligible. The percentage of failures is practical-

ly nil and in case they do occur the injection can be repeated without danger. With resonable speed in operating, the duration of anæsthesia will always be found sufficient if the dose has been properly chosen. The relaxation of the abdominal wall and of the vesical and anal sphincters is complete. This offers a distinct advantage in operations on the urethra, anus, and rectum and in hernia. Owing to vasomotor paralysis and lowered blood pressure, hæmorrhage is much less than with other methods of anæsthesia. Anoci-association is perfect and complete. We have on several occasions done high amputations on very old individuals with no evidence of operative shock. Symptoms of moderate shock sometimes develop after anæsthesia has disappeared, but it is always of a mild degree and we have never known it to be fatal. Spinal anæsthesia is very economical from the standpoint of time and assistance to say nothing of the comparative inexpensiveness of the solutions. The injection should not require more than one minute and anæsthesia is usually complete in two and one-half minutes. The anæsthetist is then free to operate or to assist in the operation. An intelligent nurse will suffice to record the pulse and respirations and to be on the lookout for dangerous symptoms. In many of the minor operations it is possible to administer the anæsthetic and then to complete the operation entirely alone. I have done this on several occasions for uncomplicated inguinal hernia and many times for infections, hæmorrhoids, and other minor operations. This would be a distinct advantage in case of an emergency operation in the home when the surgeon is isolated from his usual corps of assistants.

In the list of operations (Table I) of this group done in this hospital there has been but one death. This death occurred during spinal puncture and before the stovain had been injected. But as spinal puncture is a part of the method we reckon its mortality with that of spinal anæsthesia. It is important to note that 26 different doctors took part in the administration of the anæsthetic in this series and that none of them had used spinal anæsthesia before coming here. The only death occurred in the hands of one learning the method.

It has been a debatable point with us whether or not to include intra-abdominal pelvic operations in the group mentioned above. Practically all of our pelvic operations have been done under spinal anæsthesia and we have found it eminently satisfactory, but we hesitate to state that "it is in almost every respect the anæsthetic of choice." The chief advantages over inhalation anæsthesia are complete relaxation of the abdominal muscles requiring smaller incisions, shallow respirations, and a contracted condition of the intestines which facilitates greatly their isolation from the operative area. Post-operative distention is comparatively infrequent and when present is usually of a mild

TABLE I

Appendectomy	451
Prolapse rectum	8
Stricture rectum	37
Hæmorrhoids	264
Fistula *in ano*	97
Perineorrhaphy	48
Curettage uteri	384
Operations on cervix	28
Rectovaginal fistula	5
Vesicovaginal fistula	4
Hernia—	
Inguinal	687
Femoral	17
Ventral	30
Inguinal adenitis	330
Circumscision	377
Interior urethrotomy	180
Exterior urethrotomy	135
Hydrocele	201
Prostate	7
Amputation of penis	15
Varicocele	18
Operations on testicle	21
Plastic on urethra	9
Lower extremities—	
Amputation	98
Fractures	130
Infections	482
Ulcers, skin graft, etc.	362
Varicose veins	9
Wounds	66
Tumors	58
Osteomyelitis	42
Popliteal aneurysm	2
Operations on joints	24
Club feet	5
Cystoscopy, examination of fractures, vaginal examinations, repeated injections, emergency wounds, etc.	529
Total	5160

degree. There are some distinctly objectionable features which are not present in the first group. The Trendelenberg position which is used in a high percentage of these operations adds an element of danger which is very real, from upward diffusion of the anæsthetic solution. All deaths we have seen in which spinal anæsthesia seemed to be a factor (4) except one, have occurred when the Trendelenberg position was being used. The only instances of respiratory failure (3) have occurred while the patients were in this position. Vomiting during operation has occurred in 9 per cent of cases in which it was used as against 4 per cent when not used. Vomiting is one of the most objectionable features as it almost invariably occurs in the very midst of the operation, when the blood pressure has reached its lowest point. Nausea, restlessness, air-hunger, etc., occur more frequently than vomiting, but from the same cause, and are distressing to the patient if not to the operator. With the Trendelenberg position the average drop in blood pressure is 20 millimeters mercury and may progress to a dangerous point. All cases of marked collapse we have seen occurred when it was in use. Headache, backache, and other unfavorable postoperative symptoms are more frequent and more severe than in the first group. The average duration of anæsthesia in this region is 55 minutes. In case of very long operations or the necessity for multiple operative procedures the duration of anæsthesia will sometimes be insufficient. One is usually able to work on the perineum and vagina some time after there has been return of sensation in the abdominal wound area. For this reason it is well to finish all intra-abdominal work required first, leaving operations involving the perineum, vagina, and lower parts till last. When spinal anæsthesia is used routinely for pelvic work it is necessary to adopt a method of preparation of the patient, which will require very little time, and to operate with reasonable speed. It is possible that Babcock's technique with solutions lighter than the cerebrospinal fluid would obviate some of the dangerous and unfavorable features caused by the Trendelenberg position. As yet we have not given it a fair trial. Spinal anæsthesia could hardly be considered the anæsthetic of choice for operations in this region in the face of so many objectionable features. We have found it sufficiently satisfactory, however, to continue to use it routinely for all intrapelvic operations.

TABLE 2.—PELVIC OPERATIONS

Hysterectomy	341
Myomectomy	10
Tubes and ovaries	513
Suspension uteri	126
Total	990

NOTE: In many cases multiple operative procedures were carried out in each case. Only the most important is given. Each number represents a separate case.

Spinal anæsthesia is not sufficiently satisfactory for operations on the upper abdomen and thorax to warrant its general use here. As most of the operations in this region require considerable time, it is usually necessary to inject at the area of the cord directly supplying the operative field in order to obtain anæsthesia of sufficient duration. If the injection is made in the lumbar region and high anæsthesia obtained by diffusion upward from change in posture, the anæsthesia will not only be very light but of very short duration. With the high injection the danger of collapse and respiratory failure are markedly increased. Vomiting is more frequent and more prolonged. In a fairly high percentage of cases the anæsthesia is not complete in the upper abdomen. While there is no pain during the abdominal incision, pain and nausea are complained of and vomiting occurs when traction is made on the parietal and visceral peritoneum. The symptoms are not severe and will not interfere with the operation but the resulting shock seems to be out of all proportion to the degree of trauma. This shock added to an already lowered blood pressure may place the patient in a very dangerous condition. Part of the nerve supply to these structures comes from the lower dorsal nerves which are not always reached by the stovain. In spite of these disadvantages it is wise to choose spinal anæsthesia for operations in this region in selected cases. These will be spoken of under selection.

Operation on the upper thorax, neck and

head under spinal anæsthesia with any technique yet developed is too dangerous. It should not be used.

CONTRA-INDICATIONS

There are certain definite contra-indications to spinal anæsthesia which deserve careful consideration. Those based upon the physiological action of intraspinal anæsthetics are most important.

As there is an almost constant drop in blood pressure of varying degree, spinal anæsthesia should not be used in cases in which there is marked hypotension from shock, hæmorrhage, or any other cause. Moderate hypotension need not be considered a contra-indication except in operations on the upper abdomen or higher. Operations on the perineum, rectum, and lower extremities can be done safely even in the presence of marked hypotension, but special care is necessary in dosage and supportive measures. In exceptional cases where spinal anæsthesia would be considered the anæsthetic of choice in spite of the presence of marked hypotension operation could be safely done by giving continually during the operation, normal saline containing adrenalin, intravenously. This procedure seems to combat successfully the usual drop in blood pressure. The very old and æsthetic individuals from long continued illness seem to be unable to re-establish their blood pressure after a moderate drop. As a rule they should not be chosen for spinal anæsthesia, unless the operation is below the level of the pubis and a very small dose can be used.

Cases in which there is marked interference with free cardiac action should not be chosen; i.e., pericarditis, advanced myocarditis, mediastinal tumors and large pleuritic effusions displacing the heart. These cases almost invariably do badly under spinal anæsthesia.

Respirations are shallow and slow and the diaphragm plays an important rôle, so that spinal anæsthesia is contra-indicated in any condition which interferes markedly with diaphragmatic breathing; i.e. extensive ascites, large intra-abdominal tumors, large pleuritic effusions, etc. This does not apply to operations below the pubis. There is one important exception to this general statement. In paralytic ileus after the injection of stovain, the intestines tend to contract and the relaxation of the anal sphincter allows them to empty themselves so that the interference to respiration is quickly removed. This, of course, would not hold in mechanical obstruction.

TABLE 3.—THORAX AND UPPER ABDOMEN

Thorax—	
Wire for fractured rib	3
Liver abscess	12
Empyema	3
Wounds	2
Abdomen—	
Gastro-enterostomy	2
New-growth	17
Wounds of stomach	4
Fistula	7
Splenectomy	4
Splenopexy	2
Peritonitis	21
Operations on intestines	50
Cholecystostomy	3
Nephropexy	8
Nephrectomy	3
Ureters — plastic	1
Umbilical hernia	5
Epigastric hernia	2
Total	149

Cases in which there is existing cerebro-spinal disease should not be chosen unless there are other conditions present which render spinal anæsthesia the anæsthetic of choice.

It is dangerous to use spinal anæsthesia when there is any likelihood of a convulsion occurring at the time of or shortly after injection; i.e., eclampsia, tetanus, and hysteria. We have observed one death which occurred in an eclamptic convulsion, in a woman who was given stovain, preparatory to doing a cæsarian section. If spinal anæsthesia is especially indicated in any of these conditions, as it probably always is in eclampsia, measures should be taken to avoid the occurrence of convulsions at the time of operation.

Although we have used stovain in children quite extensively we have not found it very satisfactory. Considerable difficulty is usually encountered in trying to effect lumbar puncture, due to resistance on the part of the patient. This may result in undue trauma to the cauda equina. The percentage of failures is higher than in adults and on a few

occasions it has been necessary to give a general anæsthetic even with perfect anæsthesia on account of extreme restlessness and nervousness. It is probably better to confine the use of spinal anæsthesia to the selective field in children.

Extremely nervous individuals and those who are prejudiced against the method had better be excluded.

Marked deformity of the spinal column is not necessarily a contraindication to spinal anæsthesia. Of course, if the deformity is so marked that spinal puncture cannot be done, it cannot be used. In more than 2500 consecutive cases I have not failed to effect puncture in a single case. If there is active disease of bone or the overlying soft parts spinal anæsthesia should not be used.

SELECTION

In spinal anæsthesia a very small dose of a toxic drug is used and it is confined to a small area in its direct action. The action is temporary and there is no deleterious effect on structures remote from the area of injection. These points, in addition to its particular physiological action, peculiarly adapt it to use in certain conditions in which inhalation anæsthesia is contra-indicated. The latter is dangerous in these conditions because it places the organism in a state of general toxicity, because of its irritative action on the lungs and because of other less important physiological action peculiar to it. In a general way we consider that all operations below the level of the nipples can be done with a sufficient degree of success under spinal anæsthesia to warrant its use in this *selective field* but only in the hands of one with reasonable skill in the method. Facts bearing on physiological action should be the basis for selection in the majority of cases.

Patients in which there is a very high blood pressure, or in which a slight rise in blood pressure would be dangerous, or in which it would be advantageous to lower the blood pressure during operation, should be operated under spinal anæsthesia. The majority of patients in this class would probably be those suffering from advanced arteriosclerosis or cardiorenal disease and aneurisms. There is less impairment of renal function following operation under spinal anæsthesia than with inhalation anæsthesia. This fact has been definitely determined by a comparative study with the phenolphthalein functional renal test and by careful examination of catheterized specimens of urine before and after operation. This fact renders spinal anæsthesia doubly indicated in the presence of nephritis. Although on two occasions we have seen severe acute nephritis develop after a small operation under spinal anæsthesia, we feel that the sudden renal impairment is due more to trauma and toxic absorption than to any effect of the anæsthetic on the kidneys in the case of spinal anæsthesia. With ether anæsthesia it is more reasonable to admit a direct toxic action on the kidneys. The higher percentage of impairment of excretion as shown by the phthalein test gives reason to this assumption.

In tuberculosis of the lungs, chronic bronchitis, and all other diseases of the respiratory tract except those mentioned under contra-indications, spinal anæsthesia is preferable to inhalation anæsthesia.

Persons suffering from hyperthyroidism can undergo operations on the lower part of body with spinal anæsthesia without danger. The slowing of the pulse seen regularly with stovain may be somewhat protective. Unfortunately operation for goiter is not safe with this method.

In our series of over 7000 cases no so-called status lymphaticus deaths have occurred. Where this complication could be anticipated spinal anæsthesia would probably be preferable.

SUMMARY

Spinal anæsthesia is a method requiring special training and experience in order that reasonably good results be obtained and safety secured. This is most important in its selective field where cases presenting grave dangers are being handled.

It has a particular field of operations in which it can be considered the anæsthetic of choice in many respects.

It has a wider field of applicability in which less satisfactory but reasonably good results can be obtained.

Operations on the upper thorax, neck and head are beyond the scope of spinal analgesia and it should be attempted in this area only under very exceptional circumstances.

There are distinct contra-indications to spinal anæsthesia having their basis mainly in physiological action.

It has a selective field of applicability in which it is the least dangerous anæsthetic in certain hazardous cases.

CHOLECYSTECTOMY

By MAJOR G. SEELIG, M.D., St. Louis

THE present-day operation of cholecystectomy rests upon a basis so firm and so well established, that one hesitates before contributing to this particular chapter of surgery. And yet certain more or less weighty considerations point so definitely to the conclusion that the gall-bladder can be removed more satisfactorily and with most safety by enucleating it from the fundus downward, that there is at least warrant in emphasizing anew this procedure. In pointing out the advantages of this method as contrasted with the so-called typical cholecystectomy (i.e., primary division of the cystic duct and cystic artery, and removal of the gall-bladder from below upward) there is no thought of proselyting. The winning of surgical converts is a treacherously unsatisfactory procedure. Surgery will always represent highly individualistic effort, and those whose results warrant adherence to a satisfactory method should persist in the practice of that method. The operation of cholecystectomy, however, has furnished me so much chagrin and so many pitfalls of disaster, that it became absolutely necessary to institute a personal survey.

In speaking of pitfalls and chagrin, I have in mind chiefly two factors; namely, death following cholecystectomy in cases where a fatality was not, and in reality should not, have been anticipated; and secondly, injury to the duct system, in spite of the practice of what seemed to be diligent caution. Both of these factors rested wholly, or in large part, upon poor technique; of that I was certain. I was equally certain that as my operative experience developed and furnished me in general with commensurate surgical poise and assurance, it was failing markedly to render me this same service in the field of gall-bladder surgery. What I was uncertain about was where the fault in technique lay. A clue was furnished by the fact that ten or twelve years ago, when I was removing the gall-bladder from the fundus downward, I seemed to have had fewer difficulties, and certainly fewer qualms than I had after modifying my technique along so-called standard lines by attacking the cystic duct first. Another clue was furnished by the fact that the chapter on postoperative repair of the bile-ducts seems to be much larger in the literature of America than in that of Germany and France, where the operation of choice is removal of the gall-bladder from the fundus downward. Evidently the ducts were more frequently injured in this country.

At this stage of the inquiry it became necessary to look into the reasons governing the majority of American surgeons in their choice of the operation from below upward; and also to try to establish the fundamental surgical principles underlying the technique of cholecystectomy.

Up to 1900 the operation seems to have been done exclusively from fundus downward. In 1902 W. J. Mayo recommended this procedure and in 1903 Moynihan described the same technique. Up to 1906 all the standard American textbooks described only this type of operation. In 1906 Erdman describes the same operation but adds that in some cases, owing to disagreeable bleeding, it is wiser to divide the cystic duct first and remove the gall-bladder from below upward. At about

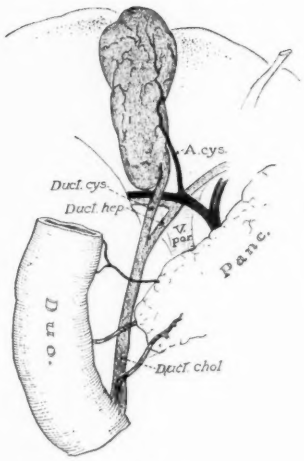


Fig. 1.

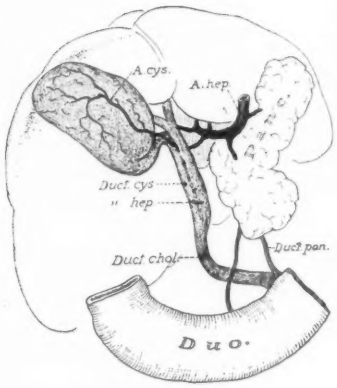


Fig. 2.

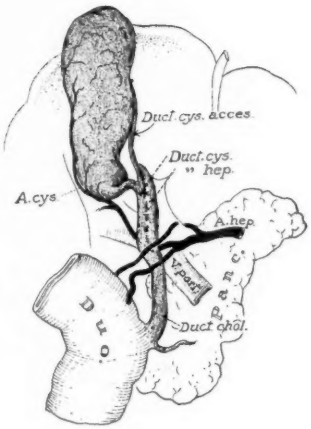


Fig. 3.

Fig. 1. The so-called normal relationship of cystic to common hepatic duct, which in reality prevails in approximately 33⅓ per cent of the cases.

Fig. 2. Parallelism of cystic and common hepatic ducts. This occurs in approximately 25 per cent of cases.

Fig. 3. Another type of parallelism with an accessory cystic duct.

this same time the Mayos and Moynihan began to advocate the operation from below upward, and largley due to their advocacy, this type of operation gained favor until now it may be fairly regarded as the typical cholecystectomy in America. This change of front in operative technique seems to rest almost solely on the notion of lessening bleeding. Moynihan adds the laconic argument that by this method "the only difficult part of the operation is accomplished first," and the Mayos point out that by this method one avoids injury to the common duct by not having any traction on it.

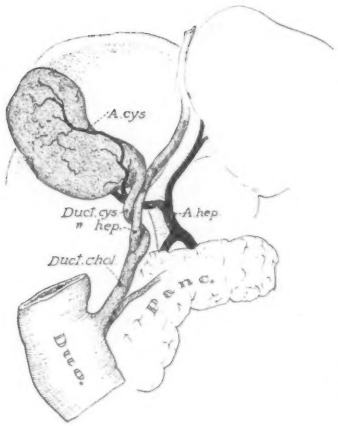
Aside from the general principles underlying the avoidance of contamination by proper isolation of the intraperitoneal field of operation, the approach through adhesions without injury to adjacent structures, and adequate, properly placed drainage, there are three definite principles underlying the operation of cholecystectomy:

1. The operation must be planned so that bleeding becomes as insignificant a factor as possible.

2. The cystic duct must be isolated before it is divided.

3. The common and hepatic ducts must be probed for the presence of stones or constrictions.

Hæmorrhage. It is undoubtedly true that hæmorrhage is best controlled at its source, by ligating the cystic artery just as it approaches the cystic duct. Most of the recent articles mention the necessity of doing this, arguing that if the cholecystectomy be done from above downward, the operator is confused by a bloody field. In the performance of cholecystectomy, three types of hæmorrhage are apt to be encountered: (1) parenchymatous bleeding from the bed of the gall-bladder; (2) arterial hæmorrhage from branches of the cystic artery distributed on the wall of the gall-bladder; (3) more serious hæmorrhage from the cystic artery itself near its origin. Both the importance and the consequences of parenchymatous bleeding have been exaggerated. It is almost invariably controlled by a small gauze pack laid against the bleeding area, and very frequently it is possible, by careful procedure, to strike an almost bloodless plane of cleavage between the gall-bladder and under surface of the liver. Arterial hæmorrhage from



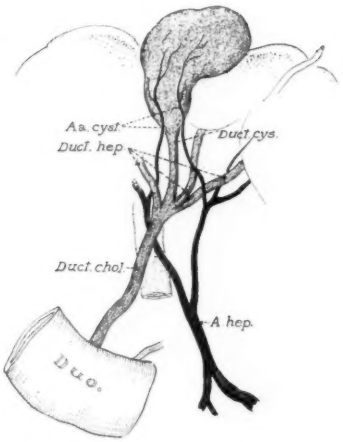


Fig. 4 (at left). Spiral arrangement of cystic duct. This type occurred in somewhat more than 33⅓ per cent of the cases examined by Ruge.

Fig. 5. An instance of three hepatic ducts, an anomaly occurring somewhat oftener than 20 per cent in Ruge's cases.

branches of the cystic artery can always be immediately controlled with artery forceps and offers no greater disadvantage than bleeding from small vessels in the course of any other operation. Indeed, very often this type of hæmorrhage is an unmixed advantage in that it aids the operator in tracing down the main branch of the cystic artery, enabling him with a few strokes of the knife to strip the vessel downward, and ligate it near its origin. This method of following the gall-bladder downward until one reaches the cystic artery, is in many respects analogous to the operation of the thyroidectomy, in which by careful step-by-step dissection, the lobe of the thyroid is freed, until its vessels of supply are brought into view.

The region of the neck of the gall-bladder is quite vascular and not infrequently an attempt to expose the cystic artery at this site, even by blunt dissection, results in the tearing of small subperitoneal vessels. This, in turn, is followed by rapid subperitoneal blood extravasation, which conceals the underlying structures and renders search for them treacherous. This unfortunate subperitoneal ooze is undoubtedly responsible for many instances of duct injury.

As a matter of fact, if one may judge from his experience in witnessing other men work, the average operator does not ligate the cystic artery separately, but grasps in his clamp the cystic artery and the cystic duct together. There is no need to emphasize here that the removal of this clamp after supposed ligature of duct and artery is quite frequently followed by a hæmorrhage that is usually perplexing and sometimes difficult to control, even if one follows Mayo's advice of carefully exposing the triangle of Calot. If, on the other hand, in removing the gall-bladder from above downward, one should encounter exactly the same type of hæmorrhage, he will find that by using the mobilized gall-bladder as a tractor he can aid himself immeasurably in exposing the field and grasping the bleeding vessel without any undue danger of injuring the ducts. We see, therefore, that parenchymatous bleeding and bleeding from the smaller branches of the cystic artery are in themselves relatively insignificant. If we are to develop a surgical principle regarding hæmorrhage, it will have to be one governing bleeding from the cystic artery itself. It certainly is not irrational to base this principle on the fact that the cystic artery is ligated more readily and with greater safety after the gall-bladder has been mobilized.

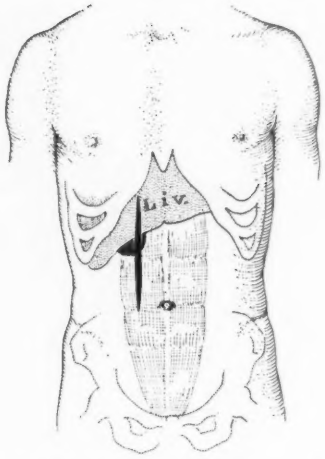


Fig. 6. Incision ordinarily used for operations upon the gall-bladder and ducts.

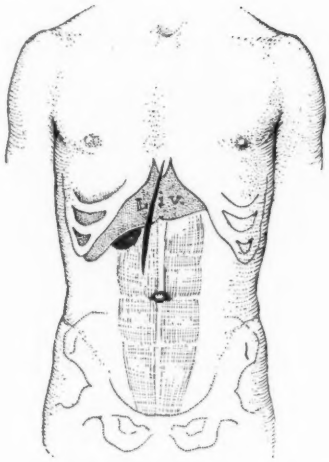


Fig. 7. Incision which furnishes much better exposure.

The second principle to be developed is the one *governing ligation of the cystic duct.* Shall ligation be performed as a preliminary procedure, or after the gall-bladder has been dissected downward so as to develop the cystic duct as a pedicle? In speaking of hæmorrhage and the best means to combat it, one hesitates to dogmatize, for the simple reason that the occurrence of hæmorrhage is dependent in no small measure upon the essential cleverness and genius of the operator. In considering the approach to the cystic duct, however, we are on much more solid ground, for the reason that we are obliged, surgically, to reckon with concrete anatomical facts.

The anatomical researches of Ruge, Rio Branco, Kehr, Delbet, and Belou do not seem to have won in America the recognition that they merit. The conclusions reached by these various investigators are in practical agreement. For our purposes, the most significant fact developed by them is that the anatomic relationships of the cystic and hepatic ducts is perplexingly variable. According to Ruge the so-called normal or typical arrangement whereby the cystic enters the hepatic at an acute angle, forming a triangle whose base is the cystic artery (triangle of Calot) maintains in only about 33⅓ per cent of cases. In approximately 25 per cent the cystic duct runs directly parallel and in contact with the hepatic duct; in most of these instances of parallelism, the two ducts are so firmly bound together by connective-tissue adhesions as to defy blunt separation, creating the impression that the two ducts are really one. In somewhat more than 33⅓ per cent of instances, the cystic is adherent to the hepatic and instead of opening into its right lateral aspect, winds under it, opening into the posterior aspect, or forms a more complete spiral and opens on the left lateral margin, or even winds completely around it, and opens on the anterior aspect of the hepatic. In 20 per cent of instances there were three hepatic duct branches instead of two and in 4.5 per cent there were five hepatic duct branches. A mere statement of these anatomic anomalies is not very impressive, but a glance at a schematic representation of them (taken from Ruge's paper) serves most admirably to emphasize the difficulty and danger attendant upon the so-called preliminary ligation of the cystic duct (see Figs. 1 to 5).

The point is simply this: The cystic duct is with greatest safety identified as a stricture running from gall-bladder to the common hepatic duct. Attempts to pick it up in the

Fig. 8. Exposure secured by using ordinary incision pictured in Fig. 6.

Fig. 9. Exposure secured by using incision pictured in Fig. 7.

region of the gastrohepatic omentum are frequently obscured by the same confusing hæmorrhage that we have already described. Even if the field be clear, and the duct recognized, it ought not to be divided until it is traced back to gall-bladder neck, and forward to common hepatic duct. Such a dissection may be uncomfortably difficult. If, on the other hand, the gall-bladder is mobilized from above downward, the cystic duct comes into view, if not automatically, at least very readily, and once in view is easily developed and freed along its whole course by exerting a little traction on the gall-bladder. I have encountered some difficulty in freeing the duct at the point where it emerges from the gall-bladder, but I am confident that this difficulty is always due to my own inexpertness. I have never experienced the slightest fear of pulling the common duct up and clamping it.

Finally we come to the third principle; namely, *ascertaining* by means of a probe, *whether or not the common and hepatic ducts are unobstructed* throughout their course. In most of the articles devoted to cholecystectomy, the authors specifically state that after the gall-bladder is removed, the ducts should be palpated for the presence of stones. It is, of course, a well-known matter of fact that stones may be present in the duct system without ever producing characteristic symptoms, or without producing them until shortly or some time after cholecystostomy or cholecystectomy has been performed. It is an equally well-known fact that the location of stones by palpation is a very illusory procedure, even when the stones reside in the easily

Fig. 10. First step in enucleating gall-bladder from above downward. *A* shows separation of fundus from its base. *B* shows relationship of cystic duct to pelvis of gall-bladder.

palpated gall-bladder. Much less reliance can be placed on palpating the ducts. Furthermore, the ducts are not infrequently partially or completely obstructed by inflammatory or congenital strictures or valve formations, none of which condition can be determined by palpation.

If palpation be supplemented by exploration of the lumen of the right and left hepatic, common hepatic, and common ducts, there will be much less likelihood of overlooking stones. It is about as rational not to explore the duct system adequately when operating for biliary disease, as it would be to remove a chronically involved appendix without thorough intra-abdominal exploration in a case

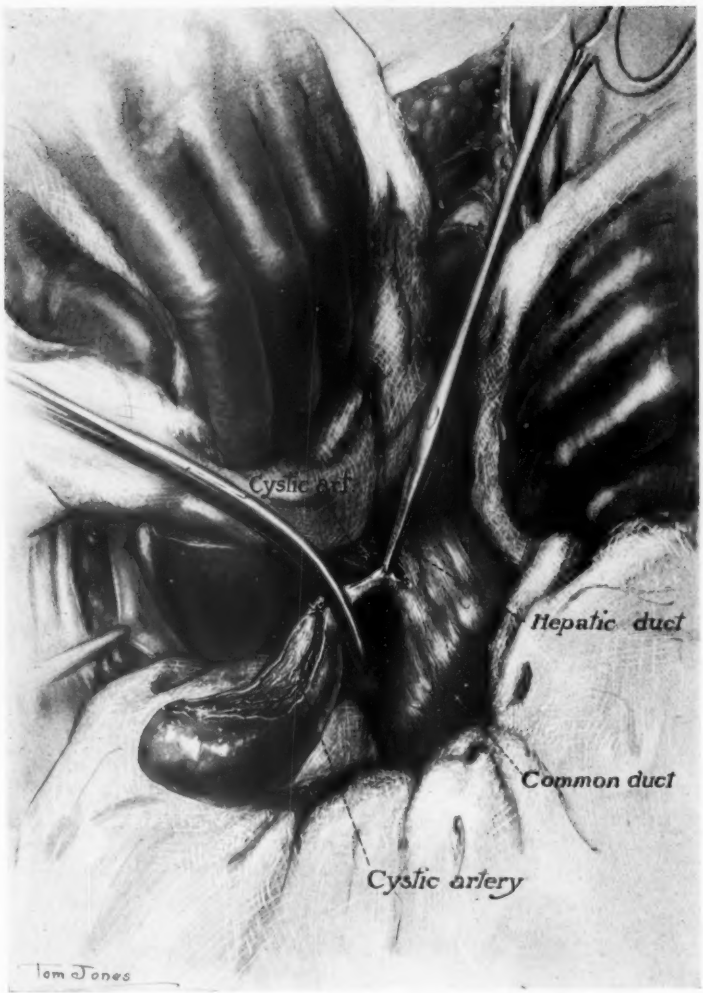


Fig. 11. Gall-bladder completely free. Cystic artery ligated. Clamp applied on cystic duct distally and artery forceps proximally to steady stump for probing.

of obscure abdominal disease. Probing of the ducts is easily accomplished, provided the cystic duct is divided not farther than one-half inch away from its entrance into the hepatic. An ordinary copper probe easily finds its way through the cystic stump, common duct, and papilla of Vater into the duodenum, or through the cystic stump, and common hepatic up into either right or left hepatic. If the cystic stump is left too long, the probe encounters the spiral valves of Heister, which blocks its passage through the duct. This probably accounts for the fact that so few operators probe the ducts.

The important conclusion is that a guiding principle in cholecystectomy ought to be thorough exploration of the ducts with a probe. Such an exploration cannot be made

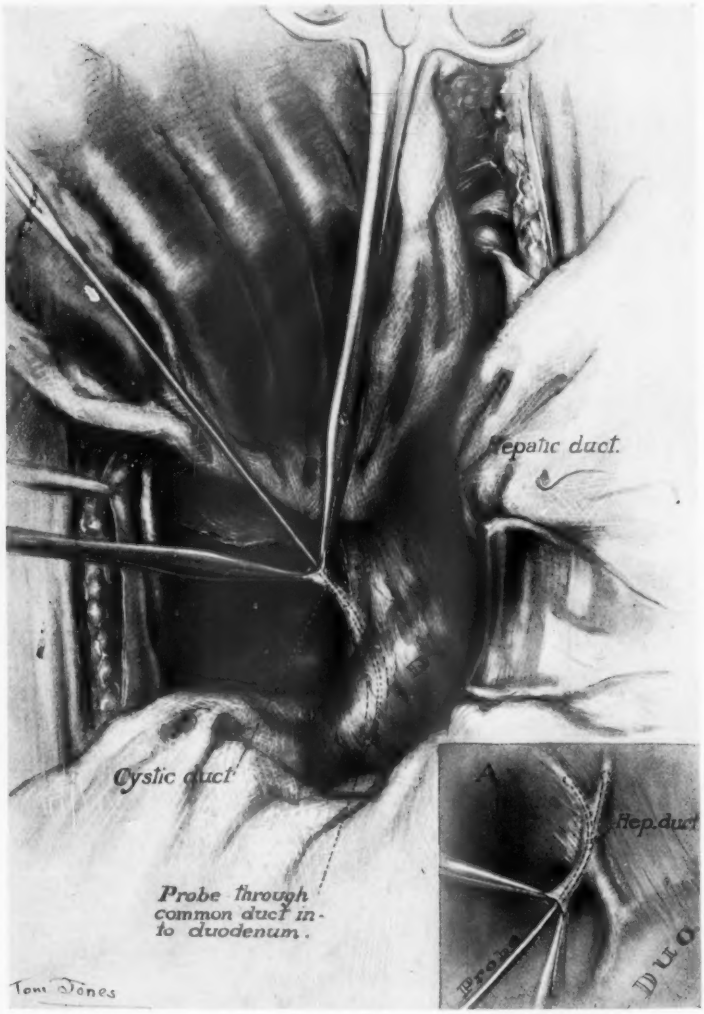


Fig. 12. Illustrating method of probing through papilla of Vater and (a) upward into the hepatic ducts.

if the popular operation of the day is performed. In this operation the cystic duct, or as I have more usually seen it performed, the cystic duct and cystic artery are clamped together doubly, divided between the clamps, and then the gall-bladder removed from below upward. After the duct has once been crushed in a clamp or ligature, it is almost impossible to find its lumen in order to gain entrance for probing. If the clamp or ligature contains both cystic duct and cystic artery, it would, of course, be hazardous to release these structures in order to attempt exploration of the duct lumen. If, on the other hand, the cystic duct is exposed from above, one may very readily clamp across it at the

proper level, divide the duct below this clamp, and clearly expose the lumen of the stump by grasping its wall with two or three artery forceps.

Bearing in mind the principles already outlined, the operation of cholecystectomy is performed as follows: An incision varying in length to meet conditions, is placed so that its upper end starts at the tip of the xiphoid cartilage, and its lower end is from one to two finger breadths to the right of the mid-line.[1] The anterior sheath of the rectus is opened along the whole length of the incision and the belly of the rectus retracted outward. The peritoneum is then opened, and if the ligamentum teres of the liver crosses the field, it is doubly ligated and divided between the ligatures. This incision has two advantages: it leaves the nerve supply of the rectus intact, and it brings one almost immediately into contact with the gastrohepatic ligament. It is difficult to understand why this incision furnishes a so much more adequate exposure than does the ordinary right rectus incision. The fact of the matter is that the difference is most striking. Figures made directly from the cadaver illustrate the point admirably (see Figs. 6, 7, 8 and 9).

After the peritoneal cavity has been opened, and the necessary exploration completed, all adhesions are separated, preferably by sharp dissection, until the gall-bladder is in full view and the free edge of the gastrohepatic ligament clearly outlined. Protective packs are then placed, special care being used to see that the right kidney pouch and the foramen of Winslow are coffer-dammed against the entrance of escaping bile.

The fundus of the gall-bladder is now grasped in a clamp, and as it is thus held tense, light strokes of a sharp knife encircle it a few millimeters from liver substance; these incisions should extend only through the serosa. Frequently a little traction on the gall-bladder suffices to strip it from the liver bed; often this stripping process is favored by dividing the serosa along the lateral margins of the gall-bladder. Frequently the gall-bladder does not yield so readily, when it becomes necessary to separate it from the liver substance by blunt dissection with the finger (Fig. 10). Some parenchymatous bleeding always accompanies this step, but it is a type of bleeding that is invariably checked by placing a small gauze pack against the bleeding surface. If a spurting branch of the cystic artery is encountered, it is immediately clamped. Even if this spurting hæmorrhage does not locate the cystic artery for the operator, it is usually very easy to detect the vessel on the inner (mesial) aspect of the gall-bladder. Once located, the vessel is dissected out of its bed and freed to a point median to the cystic duct, where it is ligated.

In stripping the gall-bladder down, one frequently experiences difficulty owing to a well-developed pelvis that conceals the cystic duct in its upper part. In such cases, the pelvis is grasped in a clamp and raised from the underlying cystic by blunt dissection (see insert figure). By putting gentle traction on the gall-bladder the cystic duct is easily outlined and can be followed down to its end point. This can usually be done by blunt dissection. Frequently a combination of blunt and sharp dissection is necessary.

After the cystic duct is exposed throughout its length, it is clamped across above the point selected for division, and held by small artery forceps below this point (see Fig. 11). The duct is then divided below the clamp and the gall-bladder disposed of. The stump of the cystic is now steadied by means of the artery forceps already attached to it, so that two or three other forceps may be used to grasp the edge of the lumen and hold it open for purposes of probing (see Fig. 12). An ordinary probe is now inserted into the lumen of the cystic stump and directed first downward until it enters the duodenum, and then withdrawn and directed upward until it enters the common hepatic from which it is directed into the right and left hepatic ducts (see insert, Fig. 12). Ordinarily, no difficulty is encountered in exploring the lumen of the various ducts, provided the cystic duct is not

[1] The transverse incision recently so ably advocated by Moschcowitz, gives an equally adequate exposure, but it will doubtlessly take some time before surgeons develop the equanimity necessary for complete division of a muscle across its fibers.

divided at too great a distance from its entrance into the hepatic.

After the ducts have been satisfactorily explored, the cystic stump is ligated with No. 1 chromicized catgut and a rubber dam drain is so placed that the end of the drain lies at the opening of the foramen of Winslow. The stump of the cystic duct lies on the upper surface of the drain which, as it is led out of the abdomen, is made to cover the raw bed from which the gall-bladder has been removed.

NOTE.— Through the much appreciated courtesy of the Department of Anatomy of the University of Illinois, there was placed at my disposal both anatomical material and the valuable services of the artist, Mr. Tom Jones.

BENIGN TUMORS OF THE INTESTINES WITH SPECIAL REFERENCE TO FIBROMA

REPORT OF A CASE

BY E. L. KING, A.B., M.D., NEW ORLEANS
From the Department of Obstetrics and Clinical Gynecology, Tulane University of Louisiana, College of Medicine.

INTESTINAL tumors are rather uncommon, benign tumors of the bowel are still more uncommon, and fibromata are very rare. Thus Heurtaux (1), in a very comprehensive review of the literature up to the date of publication of his paper (1899), could find only three cases of fibroma which had been authenticated by histological examination. Von Bruns (2) says: "Pure fibromata are very rare; fibromyomata are more frequent. Heurtaux could find only three cases that had been examined histologically. Heisig in 1897 operated on a case of fibroma of the small intestine, and could find no others in the literature." Galliard and Hutinel (3) make the same observation. They refer to Heurtaux's three cases and also mention one by Schwartz, of fibroma of the ileum, but do not give the bibliographic reference. In fact, medical literature contains but few references to benign intestinal neoplasms, and most of the articles are mere case reports. The various textbooks on pathology and on surgery mention the subject casually or not at all. Even works on tumors, such as Bland-Sutton (4) and Hertzler (5), dismiss the subject in a few words. We could find only one thorough review of the subject; namely, the series of articles by Heurtaux (1), and we feel that we can do no better than to follow the general outlines of the treatise, as he leaves little or nothing to be said in the way of general consideration of the subject.

The basis of Heurtaux's work is a previous paper by Steiner[1] on myomata of the gastrointestinal tract. Heurtaux discards all of Steiner's cases except those of intestinal tumors which have been studied histologically; 29 in number. To these he adds 3 myomata. In addition he tabulates all other authentic benign tumors found by him in the literature. He seems to have been influenced in his selection by Longuet (6), thus Longuet accepts some of the tumors reported by Tédenat (7), but for no apparent reason rejects others, although Tédenat's cases, with the exception of one, were studied histologically. We have, therefore, included these cases in the tables taken from Heurtaux and added to by us. In addition to a thorough review of the literature, I have searched through the records of the Charity Hospital (where about 10,000 operations per year are performed) for many years back, but have found no similar case. Case 9 of the table was a tumor of the mesentery, but it was included, because of the intestinal involvement present.

With the kind permission of Drs. W. J. Mayo and H. S. Plummer, I am also able to report briefly several unpublished cases of benign intestinal neoplasms which have come

[1] Ueber Myoma des Magen Darmkanals. Beitr. z. klin. Chir., 1898.

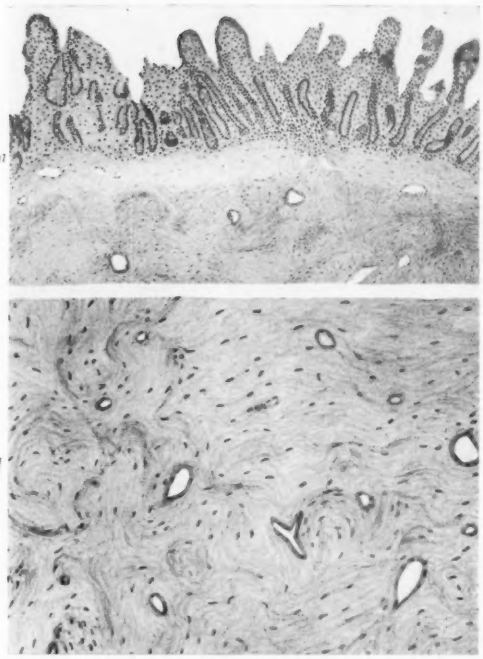


Fig. 1. Fibromata. *a*, Low power showing mucosa; *b*, high power.

to operation in the Mayo Clinic. The annual reports of the clinic were examined, with the exception of the report for 1894, which was missing, and the records of the cases found were reviewed. Thus, out of a total of 44,654 intraperitoneal operations, there were found the following:

Lipoma of colon	6
Fibromyoma of mesentery	1
Fibroma of mesosigmoid	1
Dermoid cyst of mesentery	1
Myoma of jejunum	1
Fibroma of colon	1
Retroperitoneal lipoma	1
Polyposis of colon	1
Papillomata of colon	1

Of these, it can be seen that the true solitary intestinal tumors are the 6 lipomata, the myoma of the jejunum, and the fibroma of the colon. As noted under the heading of adenoma (*q. v.*) rectal polypi (which are adenomatous) are fairly common, and there were 76 cases noted in the reports, as well as

Fig. 2. Fibroma of jejunum, Case 14.

7 cases of rectal papilloma. One case of pedunculated fibroma of the rectum was also discovered. A case of dermoid of the rectum was recorded in the 1909 report, but upon referring to the history this was found to be a sacral and not a rectal tumor. The 9 cases from this clinic are considered under the various headings.

Heurtaux states that benign tumors may arise from (a) the mucosa, adenoma; (b) the submucosa, fibroma; (c) the muscularis, myoma; (d) the fat-cells of the external coat, lipoma; (e) the fibrous tissue of the subserosa, fibroma; (f) epiploic appendages, lipoma; (g) the vessels of the intestinal wall, angioma; (h) possibly from muscularis mucosa, myoma. He thinks this last source of origin is doubtful, due to the poor development of the layer, and further states that, theoretically, tumors may spring from other tissues of the intestinal wall, but that such tumors have not as yet been reported. Two cases of teratoblastoma have also been reported (Longuet), both being rectal tumors. The fibrous tissue of the nerve sheath constitutes a probable point of origin, as Leriche (9), Branca (10), and Marie and Couvelaire (11), report cases of generalized neurofibromatosis with many intestinal tumors which without doubt are histologically identical with the cutaneous neurofibromata in these

patients. However, this has not been proved; hence we can only consider them as multiple fibromata, very probably neurofibromata. As these tumors are manifestly different from the solitary fibromata, we have tabulated them separately in order to avoid confusion.

Heurtaux was able to collect 50 authenticated tumors, classified as follows:

Fibroma	3
Adenoma	4
Myoma	32
Lipoma	8
Angioma	3
	50

In addition to these cases taken from Heurtaux, we have collected from the literature 11 fibromata (including our own case), 13 adenomata, 13 myomata, 21 lipomata, 3 fibromyxomata, 3 neurofibromata, 1 rhabdomyoma (malignant?), 2 teratoblastomata, and 1 fibro-adenoma, making a total of 119. We have also investigated many other cases, reported or referred to in the literature, which we do not consider sufficiently substantiated to be included. These cases will be referred to under the various headings.

FIBROMATA

As above noted, fibromata are very rare; in fact, Longuet doubted their existence. They may, of course, arise from any one of the several layers in which fibrous tissue is found; more frequently, however, they spring from the submucosa or the subserosa. Vaccari (12) thinks that the tumor in the case reported by him arose from the fibrils lying between the fibers of the muscularis. In our case, we are of the opinion that the tumor sprang from the submucosa, as it extended to the mucosa (see Fig. 1, *a*), which is intact. Thus the intestine was necessarily opened during its removal. As regards location, fibromata are about equally distributed between the large intestine and the small; thus, of the 14 cases reported, 5 are of the large intestine, 7 of the small, 1 of the mesentery, and 1 of the ileocæcal angle. In size, they vary from a small nut to a five kilogram tumor, the size of an adult's head. As to mode of origin, we find 6 pedunculated, 7 sessile, and 1 of the mesentery. Four of the pedunculated tumors are of the large intestine, 2 developing into the lumen of the bowel, and 1 into the pelvis. Ten of the cases are females, ranging in age from 23 to 44 years; 3 are males, age 17, 42, and 50, and in 1 the age and sex are not stated. Three of these tumors were found at autopsy, one (Lange) died after operation, and the others were cured by operation. We have investigated several other cases reported, but do not consider them as undoubted cases of fibroma. Thus Lackmann (13) refers to a report of Grossman[1] who holds the tumor to be a large omental fibroma. Lackmann, however, thinks this is really a tumor springing primarily from the wall of the transverse colon, and secondarily dissecting its way into the great omentum. The tumor was found at autopsy in a patient dying of peritonitis, after a year's illness; the exact diagnosis is not given. A large tumor was found in the omentum, and it was also connected with the transverse colon. Histologically, it was a "coarse-threaded" fibroma. Obviously, we cannot include this tumor in our list. Verneuil (14) reports a case of pedunculated fibroma of the rectum, but there is no record of a histological examination of this tumor. In the discussion of this paper, Houel stated that he had assisted Velpeau fifteen years before in the removal of a fairly large fibroma of the rectum, in which case Follin made a microscopical diagnosis of fibroma. Malassez stated that he had had a case similar to the one reported by Verneuil, which was microscopically a fibromyoma. Selby (15) reports a case of a pedunculated, intra-intestinal tumor of the ileum, which was a fibroma or a fibromyoma, but there is no record of histological examination. Lange (16) refers to a case by Peek[2] but the reference is not sufficiently specific, so I am informed by the librarian of the Surgeon General's Library. Thus we have left 14 proved cases of fibroma, and will give a brief résumé of these cases.

CASE 1. Jansen reported by Heurtaux (1). Female, 35 years old, ill with obscure digestive troubles, extreme anæmia and cachexia. Tumor in

[1] Ueber primore Tumoren im Peritoneum, Netz, und Mesenterium, und ueber einen Falls von primoren Fibrom der grossen Netzes. Inaugural Dissertation, Halle, 1897.

[2] Reines Fibrom der Dunndarms, 1904.

the left side of the abdomen as large as the fist. At operation, the tumor was found to spring from the colon, sessile; 13 centimeters of the colon was resected with the tumor. Recovery. Histologically the tumor was found to be a fibroma springing from the cellular connective tissue of the submucosa.

CASE 2. Reported by Heurtaux (1). Female, age 32; tenesmus, bloody and frequent stools. Tumor protruding through anus. Operation: ligation of pedicle and removal. Histological examination showed it to be a pure fibroma, with some irritative and vascular change. Cured.

CASE 3. Reported by Heurtaux (1). Female, age 44; tumor first noticed 15 years before operation, during first labor. Since then, the tumor protruded from anus at each stool. Obstinate constipation, a stool every 8 or 10 days, only when preceded by an enema. Pedunculated. Operation, ligation of vessels and section of pedicle by the thermocautery. Tumor was the size of an egg, weight 41 grams, 50 centigrams. Histologically, it was a pure fibroma, composed of fine fibrils, with some inflammatory changes; no evidence of malignancy was found. Cured.

CASE 4. Reported by Faure and Deplas (17). Female, age 23. Diagnosis by family physician, myofibroma of uterus. Myomectomy advised. Upon examination, a tumor was found in the median line, extending into both iliac fossæ, and rising five finger breadths above the symphysis. The tumor was hard, painless, and immovable; there was no ascites or evidence of collateral circulation. On vaginal examination, the cervix was found to be hard, slightly movable, and pushed forward. The fundus uteri could not be outlined, and the organ seemed to be continuous with the tumor. The entire pelvis was filled with this hard, smooth, regular mass, and manipulating the mass moved the cervix. At operation, a tumor the size of an infant's head was found in the pelvis, which was capped by what appeared to be the transverse colon. The tumor was freed, and it was then seen that it was capped by the cæcum and appendix, that it hung from the cæcum, that the normal uterus was retroverted behind the tumor, the adnexa were free, and there was no connection between the tumor and these organs. Operation, resection of 10 centimeters of the small intestine, the cæcum and lower colon, with the tumor. Lateral anastomosis. Resection of the thickened and inflamed omentum. Drainage. A hæmatoma developed in the cul-de-sac of Douglas and was drained. The patient was discharged cured one month after the operation. Pathological report. Tumor 14x11x8 centimeters; weight 700 grams. Pure fibrous tissue, with no muscle and no trace of sarcoma.

CASE 5. Reported by Duckworth (18). Female, age 43. Treated for some years for hysteria. Ill 14 days, and died with symptoms of pyæmia. No symptoms during life referable to the intestinal tumors found at postmortem. Autopsy. Part of ileum greatly distended; below this it was contracted. Several whitish, firm masses were found under the serous coat. On opening the bowel four tumors were found, one the size of a large walnut, the others the size of "horse beans," under the mucous membrane. The largest tumor was moderately elastic, and constricted about its center. "The distended portion of intestine was suddenly limited by a sort of pyloric band of muscular fibers about seven inches below the largest tumor, and it seemed certain that this mass had been grasped about its middle by the bowel, at the commencement of the contracted portion. Thus a partial obstruction had occurred, leading to extreme dilatation of the bowel above (the part in which the tumors were situated), the formation of a thickened band of muscular fibers at the point of constriction, and the subsequent contraction of the gut below." Microscopic examination of one of the small tumors showed it to be composed of pure fibrous tissue. There is no record of histologic examination of the other tumors. The tumors evidently sprang from the submucosa.

CASE 6. Reported by Vaccari (12). Tumor of duodenum found at autopsy. Sex and age of patient not given. A tumor was found about the size of a large nut, which protruded into the intestinal lumen, with its long axis parallel to that of the intestine. Measured 18 x 16 x 15 millimeters. The mucous membrane showed a few ulcerated areas at the summit of the tumor. On histological examination, the tumor was found to be a fibroma, singularly lamellated in structure. It apparently arose from the fine intercellular fibrils of the muscular coat.

CASE 7. Reported by Royster (20). Male, age 42. History of "indigestion," with occasional vomiting, the attacks gradually growing worse. At first, they occurred every week or two, and later became almost continuous, accompanied by severe pains in left iliac region. The patient was habitually constipated, the stools containing mucus, but no blood. Some loss of weight. Was admitted suffering from intestinal obstruction, no stool for four days, fæcal vomiting, temperature 97.6°, pulse 100, slight abdominal distention. A mass as large as the first and fairly movable was found to the inner side of the sigmoid. The descending colon and the sigmoid were dull on percussion. The impaction was relieved by enemata and oil. Then the condition was diagnosed as a tumor of the small intestine, probably malignant. At operation, an invagination was found, with a twist of the ileum. Enterotomy was performed, and tumor with its pedicle excised. Recovery was uneventful. Histologically the tumor was a pure fibroma; its size is not given.

CASE 8. Reported by Legue (21). Woman, age 30. Interval appendicectomy two years before. She returned, complaining of a large abdominal tumor. Tentative diagnosis, ovarian fibroma or fibrosarcoma. At operation, the tumor was found in the ileocæcal angle. Resection and anastomosis

was done, with recovery. The tumor was found to arise from the subperitoneal connective tissue, external to the muscularis, and to be entirely covered by peritoneum (weight and measurements not given). Histological examination showed it to be composed entirely of connective tissue; in some places were found fibers only, but in the greater part of the tumor connective-tissue cells were numerous in the midst of the fibers. No trace of infection or degeneration. The author calls attention to the relation between the operation and the development of the tumor, two years later. (Can the operation be considered as an etiological factor, or can this tumor be considered as an organization of a very marked inflammatory reaction following the operation?)

CASE 9. Reported by Lenger (22). Woman, age 34. Ill for four years with obscure abdominal pain, and gradual increase in size of abdomen. Painful urination. Diagnosis before operation was at first uterine fibroid; later, ovarian cyst. A tumor was found in the pelvis, the size of an adult's head, rounded and hard, which could be raised and separated from the normal uterus beneath. At operation, a large grayish tumor was found, which was not vascular, was fluctuating at its upper pole, and was adherent to the small intestine below. The cystic portion was punctured and one and one-half liters of reddish fluid was evacuated. The tumor was removed, and about 40 centimeters of the small intestine was resected with it, then an end-to-end anastomosis was performed. Recovery. Histologic examination, fibroma of mesentery, weight 5 kilograms, with a large pseudocystic cavity at upper pole.

CASE 10. Reported by Lange (16). Male, age 50. Large right inguinal hernia for the past fifteen years. Was admitted to Obuchov Hospital with the usual history of intestinal obstruction, which had persisted for five days; no stool during this time, constant abdominal pain, history of nausea and vomiting. Was not vomiting when admitted. On examination, patient was found to be well developed and stout, temperature normal, pulse 90 but irregular, chest negative, abdomen much distended but not rigid, painful on pressure on right side, organs not palpable. Large right inguinal hernia, in which several hard irregular masses were felt. Diagnosis; incarcerated hernia. Operations: Usual hernia incision; upon opening sac, the cæcum and ascending colon were found to be normal, with no obstruction at the ileocæcal valve. The incision was enlarged, and an invagination of the ileum was found 50 centimeters from cæcum, which was due to an intra-intestinal tumor. This area was resected, an entero-enterostomy was performed with a Murphy button, and the wound was closed with drainage. Death occurred seven hours later from "intestinal paresis and beginning peritonitis." The tumor was about the size of a walnut, very smooth, whitish in color, and was attached by a pedicle to the inner surface of the bowel, the line of attachment being drawn in in the shape of a funnel. Microscopical examination showed it to be a pure fibroma, springing from the submucosa. Its origin was demonstrated by using Weigert's method of staining, the tumor and pedicle staining red, while the mucosa took a yellowish stain.

CASE 11. Reported by Dewes (24). Woman, age 66. Constipation for twelve years, gradually worse the past three years, and very obstinate of late. Occasional vomiting spells, and the abdomen became "bloated" at times. She developed intestinal obstruction which was relieved by enemata temporarily; in two days the obstruction recurred, followed by death in a few hours. At autopsy the whole intestine was found greatly dilated, especially toward the jejunum; the stomach was about normal in size. In the region of the ileocæcal valve was found a recent intussusception about two inches long, with a round, movable body attached to the lower end. On removal and examination, there was found an oval, sessile tumor, partly covered by mucous membrane, about four inches from the ileocæcal valve, protruding into the lumen of the bowel. It measured 3.5 x 2.2 x 2.5 centimeters. Histological examination showed it to be a fibroma, springing from the submucosa. The author proves that the tumor, and not the intussusception was the cause of the symptoms and of the obstruction.

CASE 12. Reported from the Mayo Clinic. Male, age 17 years. Tumor noticed for two months in the right iliac fossa. Patient had sustained an injury to this region three weeks before appearance of tumor. No pain or bowel disorders. Laparotomy was performed elsewhere two weeks before admission to the Mayo Clinic, and a tumor, thought to be a sarcoma, was found encircling bowel. Nothing further was done. During the operation at the clinic on October 30, 1914, a tumor of the ascending colon was discovered, adherent to the scar of the previous operation. A resection and anastomosis was performed, eight inches of the ileum, the cæcum, the ascending colon, and one-quarter of the transverse colon being removed. At the end of the operation, a sponge was found in the right iliac fossa, wrapped in omentum, with an abscess pocket near it. The abdomen was drained, and the patient recovered. The pathologist reported the tumor to be a subserous fibroma.

CASE 13. Reported from the Mayo Clinic. Female, age 30 years. For the past year, had passed bright blood at times with stools. Neither diarrhœa nor tenesmus. Examination revealed a large polypoid rectal tumor. In addition, the patient suffered from hæmorrhoids. At operation the tumor and also the hæmorrhoids were removed. The pathologist reported the growth to be a fibroma.

CASE 14. Reported by Miller and King. Colored female, age 38. Was admitted to the gynecological service of Dr. C. Jeff Miller, Charity Hospital, on September 28, 1915.

Complaint, tumor in left upper abdomen. *History.* General health has always been good. Mis-

carriage at three months, at the age of fifteen. Has not been pregnant since. Menstrual history negative, except that for the past year she has had some pain before and during the period, with a steadily diminishing flow. She has noticed the tumor for about twenty months; it has grown very slowly, has caused no discomfort, and has always been freely movable. One physician made a diagnosis of floating kidney; another, of uterine tumor. She has been ill for the past two weeks, complaining of backache, fever and general malaise. She consulted a physician, who gave her some capsules (probably calomel); following this medication she developed abdominal pains, frequent loose stools, nausea, and ptyalism. There was no improvement in her condition.

Examination on admission. Colored female, somewhat emaciated; temperature 102°, pulse 120, respiration 34. General examination negative. The abdomen is relaxed, and there is no tenderness or rigidity. Liver and spleen not palpable. Left kidney is palpable, but not freely movable; right kidney cannot be felt. To the left of the umbilicus is found a tumor somewhat larger than the fist, uniformly hard and smooth. It can be moved freely in any direction, but especially to the right. Manipulation of the tumor gives no pain. The pelvic organs are negative, and the tumor is found to have no connection with them.

Urinalysis. Catheterized specimens on several occasions show a few hyaline casts and leukocytes; no other abnormalities.

Blood examination, September 30, 1915. Total white count 22,600, neutrophiles 81 per cent. Widal and cultures negative. October 4, 1915, total white count 17,700, neutrophiles 83 per cent. The temperature ranged from 100 to 102 up to the day of operation. Operation, October 5, 1915, by Dr. C. Jeff Miller. An upper left rectus incision about four inches long was made, and all abdominal and pelvic organs found negative, except for the tumor in the left hypochondrium. This was drawn into the wound (Fig. 2), and was found to spring from jejunum, being also adherent to the subjacent mesentery. There were some adhesions to other coils of the intestines. When these were freed, the tumor was found to be hard, of uniform consistency, ovoid, reddish in color, and sessile. The bowel above it was dilated to two or three times the normal size. The tumor was removed, and during this removal the intestine was opened and the mesentery wounded. The intestinal wound was closed with Lembert sutures of silk, and the mesentery sutured with catgut. The abdomen was closed in layers, without drainage.

Postoperative course. The patient left the table in excellent condition, but through carelessness on the part of the orderlies she sustained a fall from the roller, and was nearly pulseless when she reached the ward. However, she rallied nicely. The next morning the temperature was 104°, but by evening this was normal. The convalescence henceforth was rapid and uneventful, the wound healed by first intention, she was allowed up on the tenth day, and went home the following afternoon.

Pathological examination. Unfortunately, the gross specimen was not preserved. As above noted, the tumor was about the size of the fist, ovoid in shape, firm in consistency, smooth and regular. A small section of intestinal wall, with intact mucosa, was adherent to one side of the tumor.

Microscopical examination. Rush section by Dr. H. Windsor Wade, resident pathologist of the Charity Hospital, showed the tumor to be most probably a fibroma, with a possibility of its being a fibromyoma. More careful study of the fixed tissue showed it to be a pure fibroma. The following is the report of Dr. M. Couret, pathologist of the hospital and assistant professor of Pathology in Tulane University:

Histopathology of S. 15—1055 (see Fig. 1). The tumor is limited on the outer side by the peritoneal coat and on the inner by the mucous membrane. The mucous membrane, except for evident pressure upon the glandular elements and a diffuse chronic exudative inflammation, shows no change. The tumor proper is composed of dense fibrous tissue which shows here and there small areas of hyaline degeneration. The tissue-cells are well differentiated, approaching very closely to the adult type of white fibrous tissue. The nuclei are small, and elongated, and the stroma well developed. The tumor is well supplied with moderately well formed blood-vessels, indicating that it was of slow growth. Here and there are found small areas of extravasated blood. These are limited more particularly to the periphery of the growth.

Diagnosis: dense fibroma.

Under the heading of fibromata, we might include the fibro-adenomata and the myxofibromata. We found two of the former and three of the latter. Casasco (25) reports a case of a small fibro-adenoma which hung from the ileocæcal valve and occluded the orifice of the appendix. The tumor was found at autopsy in a patient dying of peritonitis. Rubli (26), Heisig (27), and Gossage (57), report three cases of myxofibroma of the small intestine. Rubli's patient was a woman age 19. The intestine, with the growth, was resected and anastomosis performed; the patient died. Heisig's case (referred to by von Bruns, 2), was not a pure fibroma, but was a case of myxofibroma of the jejunum in a man 56 years old. Invagination developed; operation and anastomosis; result, cure. Gossage reported a tumor of the ileum found at autopsy; the patient was a man aged 21; death was apparently due to peritonitis.

FIBRO-ADENOMA CASES

CASE 1. Reported by Casasco, Riv. ospedal., 1912, ii, 525. In a patient who died from peritonitis, there was found at autopsy, a small submucous tumor, pedunculated and hanging from the ileocæcal valve, occluding the orifice of the appendix. The symptoms presented were those of intestinal obstruction.

CASE 2. Reported by Thompson, J. Anat. & Physiol., 1897, xxxi, 392. In a woman, age 75, there was found at autopsy a pedunculated tumor originating at or near the pylorus, causing invagination of the pylorus and the first part of the duodenum into the second part of the duodenum.

MYXOFIBROMA CASES

CASE 1. Reported by G. Rubli, Ueber ein Fibromyxom des Darms, Wuerzburg, 1891. Woman, age 19, had a tumor of the small intestine. Operation: resection and anastomosis. Death.

CASE 2. Reported by Heisig, Inaugural Dissertation, Greifswald, 1897. Man, age 56, had a tumor of the small intestine (jejunum). The tumor was sessile in the summit of the intestine, was about 20 x 5 centimeters in size, and weighed 300 grams. The patient had suffered from abdominal pains, colics, loss of weight, and anæmia, and other symptoms indicating the presence of a tumor.

Complication: invagination. Operation: resection and anastomosis. Cure.

CASE 3. Reported by Gossage, Westminster Hosp. Reports, 1895, ix, 105. Man, age 21, had a tumor attached to the intestine, 30 inches above the ileocæcal valve. The tumor measured 2¾ x 1¼ inches. There was intestinal ulceration and dark purulent fluid in the abdomen. The patient had suffered from abdominal pain, vomiting, headache, diarrhœa, tarry stools. Tumor located at autopsy.

MYOMATA

Under this heading we are including the fibromyomata, as the various authors consulted make no attempt to separate the one from the other, nor do we consider it essential to do so. As is to be expected, these tumors are similar to uterine fibromyomata in that the relative proportions of fibrous and muscular tissue vary greatly; thus some are pure myomata, while others are composed almost entirely of fibrous tissue. In addition to the thirty-two cases reported by Heurtaux, we have collected and tabulated thirteen other cases; one each reported by Pantzer (28), Kustner (29), Lauenstein (30), Lexer (31), Vulliet (32), Hirschel (33), Prokopyeff (34), two cases reported by Riedinger (35), three cases reported by Carle (36), and one from the Mayo Clinic. We consider that all these tumors arose from the muscularis, as there is slight possibility of any of them having originated from the muscularis mucosa.

As regards the etiology of these tumors, which is of course obscure, Longuet (6), in comparing the rarity of intestinal fibromyomata with the frequency of similar uterine tumors, advances the hypothesis that in the case of the uterus the muscle is the main tissue of the organ and is by nature adapted to excessive development, while the reverse is true of the intestine. Here, the muscular layer is thin and "stable," and has very little tendency to overdevelop. In considering the structure of these growths, Heurtaux claims that they should be classed as myomata, considering the fibrous tissue (whether present in large or small amount) as merely the framework of the tumor and not as forming a part of it. Longuet (6) notes that while, as a rule, muscular and fibrous elements predominate, we occasionally find a telangiectatic form (case of Westermark). These tumors are about equally distributed between the large and the small intestine; thus, 20 are tumors of the former, 22 of the latter, 1 of the appendix, 1 of the ileocæcal angle, and in one case the location is not stated. In size they vary from a tumor the size of a small nut to the 12 pound tumor of Senn. Females again predominate, as in this series there are 22 females, ranging in age from 15 to 79 years (the majority being from 25 to 35 years old), and eighteen males, ranging from 36 to 70 years, with 5 cases whose sex and age are not given. Of these cases, 26 were cured, 8 died, 4 were cases (dying from other causes) in which the tumor was found at autopsy, and in 7, the termination is not given by the author. Twenty-four of the cures were operative cures, and 2 were cured by spontaneous expulsion of the tumor *per anum*. Twenty-eight were operated upon, with 24 recoveries, 3 deaths and in 1 the outcome was not stated. Five were not operated upon, with 2 cures by spontaneous expulsion, and 3 deaths due to the tumor. Four were autopsy cases, and the case reports of the other cases are incomplete in this regard. Here, as in our consideration of fibromata, we find that the best hope of cure lies in operation.

As in the case of the fibromata, we have found several cases reported which we felt compelled to exclude for various reasons. Thus Lackmann (13) considers the growth reported by Solin (66) a tumor of the transverse colon. However, upon referring to the original paper of Solin, we find that the tumor was not primarily intestinal, but was a myxoma apparently arising from the omentum with abscess formation and perforation into the transverse colon. Lexer (31) reports two cases taken from Koenig's Lehrbuch, ii, 576; the first was a postprostatic tumor in an adult, the second was a postrectal tumor in a 17 year old girl. Heurtaux listed the second case, but not the first; for this he must have had a good reason, probably omission of microscopical examination, hence we will not include it. Lexer also refers to a case reported by Caro[1] but does not touch upon the question of histological examination. This case is also omitted from Heurtaux's list. Selby (15) reports a case which he states to be either a fibroma or a fibromyoma, but makes no mention of histological study. Estes (38) reports a case diagnosed by him and by the pathologist as a fibromyoma; we consider this to be merely an enormous hypertrophy of the muscular coat of the bowel. The patient presented a large mass in the sigmoid flexure, apparently secondary to tubercular changes in the external layers of the bowel wall. The author describes it as "a tumor resulting from an inflammatory hyperplasia, with contraction of the longitudinal muscular and serous layers, and thereby causing circumstantial hypertrophy by crowding of muscular elements; a chronic tubercular process in the external layers of the intestine as the etiological factor." We consider this tumor to be merely a hyperplasia of the outer coat of the bowel wall, and not a true tumor. In this view we are supported by Dr. Couret, who referred us to Adami and McCrae.[1] They call such a condition "adaptative hypertrophy." Thus we feel that our opinion as to this case is abundantly substantiated. While considering the myomata, it might be well to refer to Kelly's (8) case of rhabdomyoma, though we feel that this case was most probably a rhabdomyosarcoma of vaginal origin. The patient was a child 13 months old, in whom the tumor was discovered at the age of 9 months. There was little pain and no digestive disturbances. Death resulted from an intercurrent disorder, and at autopsy the tumor was found to spring from the omentum and intestines. Microscopical examination by the "Committee on Morbid Growths" showed it to be a rhabdomyoma.

[1] Verhandl. d. freien Verein. Berl. Chir., 1897, Jan. 14.

[2] Adami and McCrae. 2d. ed. 1, p. 594.

RÉSUMÉ OF MYOMA AND FIBROMYOMA CASES[3]

CASE 1. Reported by Foerster, Virchow's Arch. f. path. Anat., etc., Berl., 1858, xiii, 270. Man, age 70, had tumor of ileum 6 or 7 lines in diameter, not obstructing the intestine, but protruding into the peritoneal cavity. Tumor discovered at autopsy, the patient dying of pneumonia.

CASE 2. Reported by Virchow, Die Krankhaften Geschwuelste, xxx vol. iii, 133. Details not given. A calcified, submucous tumor, the size of a cherry stone was found in the duodenum, in the transverse portion.

CASE 3. Reported by Boettcher, Arch. f. Heilk. v. Wagner, 1870, p. 125; Gaz. hebd. d. méd., Par., 1870, p. 319. Details not given. Tumor located in ileum; invagination.

CASE 4. Reported by Schlatzler, Bayer. aertzl. Cor.-Bl., Muenchen., 1871, No. 12, 121. Details not given. Tumor located in ileum; invagination.

CASE 5. Reported by Pellizari, Zentralbl. f. Chir., 1875, p. 223. Young girl had a tumor, weighing 500 grams, in the ileocæcal region. A diagnosis had been made of cyst of the ovary. Cure followed spontaneous expulsion.

CASE 6. Reported by Barthel, J. hebd. de med., St. Petersb., 1877, No. 36, Zentralbl. f. Chir., 1878. No. 5. Man had a tumor as large as a pigeon's egg, situated in the ileum, 8 centimeters above the valve of Bauhin. Invagination. Death.

CASE 7. Reported by Carlier and Van der Epst, J. de. méd., chir., et de Pharm., Brux., 1881, p. 140. Woman, age 21, had a tumor of the rectum. She suffered from tenesmus, hæmorrhages, and abdominal distention. The tumor protruded at defæcation. Operation: ligature of pedicle and removal. Later the ligature detached itself. Cure.

CASE 8. Reported by Wesener, Virchow's Arch. f. path. Anat., etc., Berl., 1883, xciii, 377. Man, age 55, had a telangiectatic tumor of the duodenum. The tumor was as large as a plum, continuous with

[3] Cases 7, 10, 11, 16, 18, 24 and 26 also reported by Longuet (6).
Cases 5, 16, 24, and 26 also reported by Lackman (13).
Cases 5, 12, and 19 also reported by Faure Deplas (17).
Cases 7, 10, 11, 13, 16, 18, 24 and 26 also reported by Lexer (31).
Cases 10 and 30 also reported by Estes (38).
Cases 16, 19, 24 and 26 also reported by Riedinger (35).
The first 32 cases are taken from Heurtaux's report.

another tumor 7 x 3½ centimeters, which rested upon the pancreas, compressing the common bile-duct. Died.

CASE 9. Reported by Wesener, ibid. Patient had tumor of the duodenum as large as an apple.

CASE 10. Reported by Heurtaux, Gaz. méd. de Nantes, 1884, p. 135; Arch. prov. de chir., Par., 1896. Woman age 50, had tumor as large as a small apple at the junction of the ascending colon and the transverse colon. There had been signs of intestinal obstruction twice; the first time 12 years ago, the second time 3 years ago. Finally intestinal obstruction and spontaneous rupture of the pedicle. The tumor remained enclosed above the valve of Houston; extracted. Cured.

CASE 11. Reported by Tédenat, Montpelier méd., 1885. Man, age 46, had two myomata of the rectum. The patient had suffered from rectal hæmorrhages, constipation, and colics. One tumor was spontaneously expelled; the other removed by crushing the pedicle. Cured.

CASE 12. Reported by Fleiner, Virchow's Arch. for Path. Anat., etc., Berl., 1885, ci, 496. Man, age 52, had a tumor of the ileum in the vicinity of the ileocæcal valve. Invagination. Resection of the intestine by Czerny. Cured.

CASE 13. Reported by Koenig, Lehrb. d. spec. Chir., 1885, ii, 455. Girl, age 17, had a red, pedunculated tumor of the posterior wall of the rectum, the size of a pigeon's egg. Operation: ablation; cured.

CASE 14. Reported by Heurtaux, Soc. anat. de Nantes, 1887, Nov.; Arch. prov. de chir., 1896. Woman age 37, had a tumor of the rectum. The tumor was glossy, ovoid, and was inserted at the posterior wall by a pedicle as large as the finger. The tumor was as large as an average sized pear. For three years the patient had suffered from constipation and colicy movements. During the past month the colics persisted almost constantly, with bearing-down sensation and a sensation of a foreign body in the rectum; mucous and bloody stools. For five days preceding operation there had been obstruction, with violent colics, vomiting, abdominal distention. The tumor was drawn down through the anus, the pedicle tied in two places, and cut between the ligatures. Cured.

CASE 15. Reported by Mercer, Med. Record, 1888, xxx, 67. Woman, age 34, had a globular, pedunculated tumor weighing 475 grams, situated in the ileum. The patient had suffered from digestive troubles and the stools were bloody. Death from hæmorrhage.

CASE 16. Reported by Senn, Zentralbl. f. Chir., 1891, p. 662; Weekly M. Rev., 1891, Mar. 21. Woman, age 44, had a tumor of the anterior wall of the rectum. The tumor weighed 15 pounds and protruded into the abdominal cavity. The tumor could be palpated in the lower left portion of the abdomen; it was movable, and there was an accompanying ascites. Diagnosis: ovarian cyst. Laparotomy. The rectum was opened posterior to the bladder, the tumor removed, and the intestine sutured. Cured.

CASE 17. Reported by Lockwood, Brit. M. J., 1892, p. 966. Woman, age 30, had a tumor of the ileum, 70 centimeters above the cæcum. The tumor was calcified in the center and had a pedicle three-fourths inch in diameter. Complication: invagination, 14 centimeters in length.

CASE 18. Reported by MacCosh, Tr. Path. Soc., 1893, April 26. Man, age 34, had a tumor of the posterior wall of the rectum. It was hard to the touch and the mucosa seemed to adhere to it. The patient had had difficult defæcation for some years, and the stools were reddish. An iliac colostomy was done, followed by the operation of Kraske; six weeks later, the iliac anus was closed. Cured.

CASE 19. Reported by Lode, Wien. klin. Wchnschr., 1894. Man, age 66, had a subserous tumor of the ileum, a short distance from the cæcum. For two years, the patient had suffered from sudden vomiting at times. A painful tumor was palpable in the cæcal region. Death by suicide.

CASE 20. Reported by Fenger, Chicago Clin. Rev., 1894. Man, age 75, had a tumor the size of a large walnut in the region of the ileum. The tumor was covered by serous membrane. The patient had suffered from frequent abdominal pain, and for one year there had been attacks of ileus. Laparotomy, incision of the intestine, and removal of the tumor, suture. Cured.

CASE 21. Reported by Geissler, Deutsche med. Wchnschr., 1894, No. 48. Woman, age 28, had a tumor of the jejunum 3 x 5 x 5 centimeters, jutting into the intestine. For six weeks the patient had suffered from intense vomiting and pain. There was a 15 centimeter invagination. Death.

CASE 22. Reported by Kukula, Wien. klin. Rundschau, 1895, No. 20. Man, age 71, had a tumor of the small intestine. The tumor measured 6 x 3 x 5 centimeters, and was implanted on the convexity of the intestine, causing strangulations. For 20 years the patient had had a hernia; it increased little by little to the size of a child's head. Signs of strangulation developed. Herniotomy performed but the abdomen was not thoroughly explored. Following the herniotomy there was a retrograde strangulation above the hernia. Laparotomy and resection of 20 centimeters of the intestine with the tumor. Cured.

CASE 23. Reported by Eppinger, Praeparat d. path. Anat., 1896. Woman, age 20, had a tumor of the appendix as large as a small apple. In addition there was a myoma of the clitoris. The tumor was found by chance at autopsy. Death from typhoid.

CASE 24. Reported by Berg, Zentralbl. f. Gynaek., 1896, No. 1. Man, age 56, had a tumor in the sacral excavation of the rectum. The tumor was fixed to the ulcerated mucosa. The patient had suffered 8 or 10 years from constipation, accompanied by serious hæmorrhages. The operation of Kraske was done, but as a fistula remained,

a second operation was done which cured the fistula. The patient was cured.

CASE 25. Reported by Albert, Wien. klin. Wchnschr., 1896, No. 26. Woman, age 41, had a tumor of the intestine which could not be definitely located. For six months the patient had suffered from alternating constipation and diarrhœa, but no appreciable tumor could be palpated. Diagnosis: chronic stenosis of the intestine. Complication: invagination which was found to contain a pedunculated myoma the size of a nut. Laparotomy and resection of the invaginated portion. The outcome not given.

CASE 26. Reported by Westermark, Zentralbl. f. Gynaek., 1896, No. 1; Scalpel, 1896, May. Woman, age 49, had a tumor of the anterior wall of the rectum. The tumor was as large as an adult's head and was fluctuating in consistency. For 18 months the patient had suffered from pains in the abdomen and the sacrum, from constipation, and urinary disturbances. There had been rectal hæmorrhages, and a round, smooth tumor could be palpated in the hypogastrium to the right. Laparotomy revealed a friable tumor springing from the rectum by a pedicle. Death the fourth day from ileus.

CASE 27. Reported by Caro, in Berl. klin. Wchnschr., 1896. Man, age 51, had a tumor of the jejunum. The tumor was twice the size of a child's head and was adherent to the descending colon, to the sigmoid, and to the ileum. The patient had had intestinal troubles for five months, ileus for four days. Patient admitted in collapse. Operation: an artificial anus was made. Death followed in four hours.

CASE 28. Reported by Hollander, Zentralbl. f. Chir., 1896, p. 310. Woman, age 79, had a tumor of the colon, as large as a plum. Invagination. Laparotomy, enterotomy, and removal of the tumor. Cured.

CASE 29. Reported by Pfannenstiel, Zentralbl. f. Gynaek., No. 26. Woman, age 34, had a tumor as large as a child's head, on the posterior surface of the descending colon; another in the pararectal tissue which sprang from the mucosa. The tumors weighed together 4 kilograms. The patient had suffered from weakness, incontinence of urine, and dysuria. Laparotomy and removal of the tumor. Cured.

CASE 30. Reported by Krukenberg, Zentralbl. f. Gynaek., 1897, p. 1515. Woman, age 37, had a tumor of the ascending colon. The tumor was the size of a fist, and was adherent by a surface of 2 x 1.5 centimeters to a dilated portion of the colon. The patient had suffered from sharp pains in the lower abdomen to the right. A tumor, hard and movable, appeared to be attached to the uterus, but under anæsthesia was found not to be so attached. Laparotomy and extirpation. Cured.

CASE 31. Reported by Rosi, Morgagni, 1897, pt. 1, No. 3, 211. Man, age 56, had a tumor 9 x 6 centimeters which was continuous with a portion of the intestine and appendix. For 20 years he had had pain in the inguinal region. The tumor extended from the intestine to the testicle and was prolonged into the iliac fossa. The tumor and testicle were removed. Cured.

CASE 32. Reported by Petrow, Ann. d. russ. Chir., 1898, No. 1. Man, age 37, had a tumor of the ileum. The tumor was as large as a goose egg and was 227 centimeters from the valve of Bauhin. It was adherent to the true pelvis, and at its center a cavity communicated with the intestinal canal by a channel the thickness of the finger. Complications: abscesses of the liver and lungs; sepsis. Death at the end of 18 days.

CASE 33. Reported by Pantzer, Am. J. Obst., N. Y., 1913, lxviii, 955. Woman, age 15, had a tumor 10 inches from the cæcum, which was sessile on the crest of small intestine. The tumor measured 1½ x 2¼ inches. The symptoms were those of obstruction. Complications: intussusception in ileum. Three inches of the small intestine were resected. Cured.

CASE 34. Reported by Kustner, Verhandl. d. gynaek. Gellsch., 1903, iv, 72. Woman, age 53, had a tumor the size of a child's head springing from the muscularis of the sigmoid. No details given.

CASE 35. Reported by Lauenstein, Deutsche Ztschr. f. Chir., 1906, lxxxv, 267. Woman, age 33, had a pedunculated tumor in the transverse colon, which probably sprang from the submucosa. There had been vague intestinal symptoms with evidences of a tumor to the right of the umbilicus. Enterotomy with ligation of the pedicle and removal of the tumor. Cured.

CASE 36. Reported by Lexer, Verhandl. d. deutsch. Gesellsch. f. Chir., 1902, xxxi, 440. Man, age 35, had a tumor of the rectal wall; posterior to the rectum, the mucosa was ulcerated. The patient had been ill for several years; there had been tenesmus and rectal bleeding. Operation: resection of rectum and tumor and establishment of artificial anus. Cured.

CASE 37. Reported by Vulliet, Rev. méd. de la suisse Rom., Geneva, xxvii, 467. Man had a pedunculated tumor 12½ x 14 x 6.5 to 9 centimeters, springing from pelvic colon. There was a large cyst and several small cysts. For two years there had been an enlargement of the lower abdomen; following an injury the pain has become worse of late, with obstinate constipation. Laparotomy and ligation of the pedicle. Cured.

CASE 38. Reported by Riedinger, Zentralbl. f. Gynaek., 1898, xxii, 921. Woman, age 38, had tumor in the lower abdomen, thought to spring from the bony pelvis. The tumor measured 20 x 12 centimeters and arose from the anterior wall of the rectum and lower sigmoid. The symptoms before admission not known; on admission, she showed symptoms of ruptured uterus. Complications: ruptured uterus; fœtus free in abdominal cavity. Hysterectomy and removal of tumor. Death from peritonitis.

CASE 39. Reported by Riedinger, ibid. Woman, age 24, had tumor in the splenic flexure and descending colon. The tumor was the size of a man's head, 23 x 21 x 15 centimeters, and weighed 3700 grams. The symptoms were characteristic of tumor. The tumor was removed; recovery.

CASE 40. Reported by Hirschel, Virchow's Arch. f. path. Anat., etc., Berl., 1904, cxxvii, 167. Sex and age not given. A tumor the size of a pigeon's egg, was situated 15 centimeters from the duodenojejunal flexure. It was hat-shaped, of fairly firm consistency, bluish, pedunculated. It had a cavity connecting with the intestinal cavity. The tumor had produced no symptoms and was discovered at autopsy, the patient having died of sepsis of an unknown cause. Complications: Meckel's diverticulum 8 centimeters long about 1½ centimeters from the ileocæcal valve.

CASE 41. Reported by Prokopyeff, Kharkov. M. J., 1914, xvii, 79. Woman, age 28, had a tumor the size of a mandarin to the right of the uterus. It was hard and freely movable. At operation it was found to be attached to the small intestine. It measured 7½ x 5½ x 3 centimeters and weighed 95 grams. There had been pain in the right lower pelvis with no other complications. The tumor was removed and the patient was cured.

CASE 42. Reported by Carle, Pel guibil. didat. d. Camillo Bozzolo, 1904, p. 821. Man, age 31, had tumor about twice as large as a uterus at term. It was cystic and attached to the intestine about 50 centimeters from the ligament of Treitz. There had been pain in the region of the liver, accompanied by some digestive disturbances. The tumor was removed and intestinal anastomosis performed. Cured.

CASE 43. Reported by Carle, ibid. Woman, age 44. The tumor sprang from the small intestine about 50 centimeters from the ileocæcal valve. It was the size of a closed fist and was somewhat irregular and cystic. For 19 years there had been abdominal pains, digestive difficulties, obstinate constipation alternating with diarrhœa. For the past year there had been symptoms of a tumor. Parts of the tumor had become sarcomatous. Removal of tumor and enterorrhaphy. Cured.

CASE 44. Reported by Carle, ibid. Man 25, had tumor of the rectum. The tumor was as large as an egg and was covered with intact mucosa. There had been difficulty and pain on defæcation, with a sensation of foreign body in the rectum. The stools were bloody. The tumor was removed. Cured.

CASE 45. Reported by the Mayo Clinic, 1912, July 27. Man, age 57, had tumor the size of a walnut six inches below the duodenojejunal flexure. The patient presented no symptoms which might be attributed to tumor, but did present the usual symptoms of duodenal ulcer. Complication: chronic perforating ulcer of duodenum. Operation: gastroenterostomy and resection of the jejunum. The patient was cured.

ADENOMATA

Only a few cases of fairly large, single adenomata are reported. Several authors, e.g., Tédenat (7), consider adenomata as being fairly common; he states that the majority of mucous polypi of the rectum are adenomata and that they are especially liable to be found in infants, causing free hæmorrhages, which are usually ascribed to hæmorrhoids. This author quotes Bryant[1] who claimed that hæmorrhoids are very rare in infants; Bryant also considered adenomata to be rather common, quoting 30 cases in his own experience (5 adults, 14 boys, and 13 girls). In 1 case, Bryant found three tumors, and Allingham (quoted by Tédenat) reported twelve in 1 case. Tédenat saw Forchier of Lyons operate upon a patient (age not given) in whose intestine over one hundred of these tumors were found. The same author quotes Bokai of Pesth who considered these tumors very rare, having found only 25 cases of polypi in 59,970 children. As histological study of tissues was by no means the routine at that time, we should not place too much reliance upon these widely divergent opinions. In a more recent paper Smoler (39) reports 124 cases, and in a still more recent article, Soper (40) reports 60 cases of "polyposis" of the colon, adding 1 of his own. This title given to these tumors by Soper is a very good one, and will probably cover most of the cases of multiple tumors reported by Smoler and others. An analysis of the 124 cases reported by Smoler reveals the fact that only 32 of these cases were studied histologically, and of these, 11 could be classed as solitary adenomata, 9 as polyposis of the colon (2 also presented polyposis of the small intestine) and 12 as rectal polypi. There is no mention of microscopical examination in the remaining 92 cases; of these, 7 were in the duodenum, 5 in the jejunum or ileum, 14 in the colon, and 66 in the rectum. Many of these were autopsy cases, and no doubt were really adenomata; the rectal cases were practically all multiple polypi. Leichtenstern (47) gives no case reports, merely stating that, out of 128 cases of intestinal polypi, 75 were in the rectum. Sandberg (48) and Bryant

[1] Practice of Surgery. London: 1879.

(49) report papillomatous growths, and Hewitt (50) reports 2 cases of "fibrous polypi" of the small intestine; but none of these was studied microscopically, except Hewitt's second case, which was stated to be "decidedly of a fibrous nature." Allingham (51) reports a tumor the size of a fœtal head in the neighborhood of the rectum, which histologically was a "polypoid growth." Under the heading of adenomata we have included only those cases in which one (or a few) tumors of fair size are found. Thus Case 3 of our table, with sixty or eighty small polypi of the rectum, would not be included were it not for the large tumor higher up in the large intestine, which produced invagination. Adenomata are usually small (about the size of a nut or smaller), though rarely larger ones are found, as Cases 2 and 5 in the table. They are generally sessile; at times pedunculated, with a short thick pedicle. As a rule, they are rather firm and regular. The usual location is the large intestine. This is also true of the polypi, as stated by Soper. Of his 61 cases, in only 9 was the small intestine involved. Of the 17 cases which we have found in the literature, 12 were tumors of the large intestine, and 5 of the small intestine. As stated by Tédenat and by Soper, these tumors, especially the polypi, are found frequently in infants, though no age is exempt. Invagination and obstruction in the case of the large single tumors is a frequent and serious complication, occurring four times and causing death in Cases 3 and 4. Here again surgical treatment is the method of choice, operating before the development of invagination, if possible.

(The separation of the large tumors from the small, multiple ones is purely arbitrary, since the latter are histologically adenomata just as much as the former. This division is made merely for the sake of convenience.)

RÉSUMÉ OF ADENOMA CASES[1]

CASE 1. Reported by Pozzi,[2] Soc. de chir., 1884. Woman, age 38, had a sessile tumor as large as an almond. The tumor was situated in the rectum. The patient suffered from hæmorrhages, tenesmus, and diarrhœa. Removal of the tumor.

[1] The first four cases are taken from Heurtaux's report.

[2] Tédenat states that Pozzi reported two cases but gives no details.

CASE 2. Trèlat, Soc. de chir., 1884, describes a tumor of the rectum the size of a fist. Cured by linear crushing.

CASE 3. Reported by Guillet, Soc. Anat., 1887, p. 16. A man, age 24, had 60 to 80 tumors of the rectum and another in the cæcum producing invagination. The patient had had several attacks of pain in the right iliac region accompanied by vomiting and constipation. An invagination 50 centimeters in length was found. The tumor was removed, but the invagination persisted. Death.

CASE 4. Reported by Lyot, Soc. anat., 1891. Child five months old, had a single tumor as large as a half nut, in the ascending colon. The child had suffered from colics and had passed blood. An ileocolic invagination was present. Death.

CASE 5. Reported by Tédenat, Montpelier méd., 1885. Woman, age 49, had a pedunculated mass on the posterior wall of the rectum, 4 to 5 centimeters from the anus. The tumor was bossed, reddish, and the size of a large pigeon egg. The patient had had colic and had passed blood. Operation: the pedicle was ligated and the tumor removed. Cured.

CASE 6. Reported by Wagner, Schmidt's Jahrb., 1859, ii, 92. In a male, child age 5, pedunculated tumor was found at autopsy, in the lower portion of the ileum near the mesentery. Rectal polypi also found. The child had died of miliary tuberculosis and hydrocephalus.

CASE 7. Reported by Lambl, Franz Josef Kinderspital, Prag., 1860, i, 378. In a female child, age 2, dying of enterocolitis. There was found at autopsy a mass in the submucosa of the ileum.

CASE 8. Reported by Langhans, Virchow's Arch. f. path. Anat., etc., Berl., 1867, xxxviii, 559. In a patient who apparently died of tuberculosis, there was found at autopsy a broad based tumor, 13 by 7 millimeters, in the ileum, about 3 feet from the ileocæcal valve.

CASE 9. Reported by Korojan, Wien, klin. Wchnschr., 1899, No. 9. Man, age 23, had a pedunculated tumor the size of a nut in the lower ileum, which produced invagination. There was a second tumor 10 centimeters higher up and some smaller ones. The pedunculated tumor was found to be an adenoma. For 22 months, the patient had suffered from abdominal pains and vomiting. A mass was felt in the left lower abdomen. At laparotomy an invagination was found which was reduced. Enterotomy and removal of tumor. Cured.

CASE 10. Reported by Smoler, Beitr. z. klin., Chir., 1902, xxxvi, 149. Man, age 23, had walnut-sized pedunculated tumor in lower ileum. The patient had had colics for a year and a half, the pain being located especially in the lower right abdomen. There were frequent attacks accompanied by constipation and weakness. Invagination. Enterotomy and removal of tumor. Cured.

CASE 11. Reported by Whitehead, Brit. M. J., 1884, p. 410. A patient, 21 years of age, had a tumor the size of a hazel nut in the rectum; also two

tumors in the sigmoid and descending colon. For ten years there had been rectal hæmorrhage. The tumor protruded on defæcation. The patient also suffered from anæmia. The rectal tumor was removed through the anus. Cured.

CASE 12. Sheild, Tr. Lond. Path. Soc., 1888, xxxix, 130. Reports the case of an orange-sized pedicled rectal tumor which had been present for eight years. The patient suffered from hæmorrhages and rectal stricture, also from anæmia. The tumor was removed through the anus. Cured (?).

CASE 13. Reported by Vergely, Jahresber. u. d. Forts. d. Chir., 1898. Female, age 22, had a large pedunculated tumor 8 centimeters from the anus; also several polypi. For several years the patient had suffered from severe rectal bleeding and other symptoms of tumor. Anæmia was also present. The tumor and polypi were removed by ligation and cauterization of their pedicles. Cured (?).

CASE 14. Reported by De Fontgazon and Aubaret, ibid. Man, age 58, had a pedunculated rectal tumor, the size of an egg. Tumor removed. (Cured ?).

CASE 15. Reported by Smoler, Beitr. z. klin. Chir., 1902, xxxvi, 164. Woman, age 60, had pedunculated rectal tumor size of an egg. Several rectal polypi removed 4 years before. Recently there had been blood in the stools and protrusion of the tumor through the anus. Operation: incision through posterior vaginal wall, separation of rectovaginal septum, and removal of the tumor. Cured.

CASE 16. Reported by Smoler, loc. cit. p. 169. Woman, age 64, had a pedunculated tumor of the rectum, 5 or 6 centimeters from the anus. The patient suffered from diarrhœa and difficulty in defæcation. The tumor was removed through the anus. Cured.

CASE 17. Reported by De Santi, Tr. Path. Soc. Lond., 1901, lii, 72. Man, age 51, had a mass palpable in left iliac fossa, which was found to be a papillary adenoma of the sigmoid. The patient had suffered pain for 15 months, loss of weight, diarrhœa, at times blood in the stools, and recently vomiting had set in. Laparotomy and removal of the tumor. Cured (?).

LIPOMATA

These tumors are fairly common; we found 29 cases in the literature, and many reports of tumors which were apparently lipomata, but had not been examined microscopically. Heurtaux reports 8 cases (the first eight of the table). Hiller (45) reports 1 personal case, and gives the details of 16 cases gathered from the literature. In the cases of Castelain (also reported by Heurtaux), Albrecht, and Link, he states that the diagnosis was confirmed by the microscope. In the other cases, he apparently accepts autopsy findings or the descriptions given by the reporters of the cases as sufficient verification of the nature of the tumor. Ward (46) reports 1 personal case (verified histologically), and also reports 2 cases occurring in the practice of Dr. W. G. McDonald of Albany, New York. Only one of these latter cases seems to have been studied histologically, hence we do not include the other in our list. Ward gives short summaries of 34 cases of intestinal lipoma, in only one of which (Fuchsig) is there mention of histological examination. Tumors which were clinically lipomata are also reported by Zum Busch (52), Richardson (53), Voss (54), Roy (55), and Turner (56).

In the case of lipomata, we naturally find the same symptoms, complications, etc., which characterize the other benign tumors. These growths are found chiefly in the large intestine, occur most frequently between the ages of 40 and 60, and occur with equal frequency in both sexes. Thus, of the 29 cases, 15 were in men, 13 in women, and in 1 case the sex was not stated. The ages of the patients varied from 32 to 83 years, but most of them were between 40 and 60. Eighteen of the tumors were of the large intestine, eight of the small, and in three cases the location was not stated. Twenty cases were operated upon, with 14 cures, 4 deaths, and in 2 the result was not stated. In 6 cases, the tumor was expelled spontaneously, 5 were cured; in the other the result was not stated, but we can safely assume a cure. Three were autopsy cases.

RÉSUMÉ OF LIPOMA CASES

CASE 1. Reported by Castelain. Gaz. hebd, No. 20,187. Man, age 43, had a lobulated tumor, 12 x 6 centimeters, with a pedicle 2 to 3 centimeters thick, probably rectal. Patient suffered with tenesmus. Spontaneous expulsion of tumor.

CASE 2. Reported by Avezou. Bull. Soc. anat., 1870, Mar. 26. Woman, age 83, had a tumor size of pigeon's egg, weight 20 grams, in rectum. Patient suffered with alternating constipation and diarrhœa, and sensation of weight in the rectum. Spontaneous expulsion of tumor.

CASE 3. Reported by Morel. Bull. Soc. anat., 1876. Woman, age 46, suffered, especially after meals, with pain above pubis, which continued to grow worse. Location of tumor not given. Spontaneous expulsion.

CASE 4. Reported by Voos. Lond. M. Soc., May 1881. Woman, age 47, had tumor size of an

egg, nodular, with a long pedicle, in rectum. Tumor appeared through anus at defæcation. Later stools were bloody. Invagination. Operation: enucleation by incision of mucosa. Result not given.

CASE 5. Reported by Tuffier. Soc. anat., 1881, Prog. méd., 1882. Woman, age 43, had tumor of left iliac region the size of a large orange. Patient suffered with pain in left iliac region and obstinate constipation for one year, with stools every 6, 10, or even 20 days. Invagination for 12 days. Tumor felt 1 centimeter from anus. Operation: lateral laparotomy; artificial anus. Death from peritonitis.

CASE 6. Reported by Tédenat. Montpel. méd., 1885. Woman, age 64, had small rectal tumor 13 x 6 millimeters. Patient had bloody stools every 4 days, with weight in rectum. Operation: linear crushing. Cured.

CASE 7. Reported by Notan-Larrier and Roux. Soc. anat., Par., 1897, May. Woman, age unknown, had tumor of duodenum, 6 x 3 centimeters with small pedicle, 8 centimeters from pylorus. No symptoms. Death from pneumonia, the tumor being found at autopsy.

CASE 8. Reported by Heurtaux. Arch. prov. de Chir., 1900, ix. Woman, age 60, had tumor, 67 x 48 x 40 millimeters in superior part of descending colon. Patient had suffered with colics and pain in left hypochondrium for 8 years, with weight in rectum and side; finally, complete obstruction. Subacute invagination for 15½ days. Operation: pedicle, as large as index finger, was ligated and cut. Invagination was reduced spontaneously. Cured.

CASE 9. Reported by Tédenat. Montpel. méd., 1885. Man, age 65, had postrectal subserous tumors size of fist (found at autopsy). Suffered with intestinal obstruction at times. Death from strangulated right inguinal hernia and peritonitis. Hernia was probably produced by straining due to obstruction by tumor.

CASE 10. Reported by Tédenat, ibid; Gaz. hebd., 1870. Man, age 43, had tumor 12 x 6 centimeters. Patient suffered with obscure digestive disorders; infrequent and difficult stools; obstruction at times. Finally had a more severe attack and spontaneously expelled the tumor. Cured.

CASE 11. Reported by Langemark. Beitr. z. klin. Chir., xxviii, 247. Woman, age 57, had tumor size of a walnut near hepatic flexure. Patient suffered with abdominal pain and indefinite intestinal troubles. Chronic ileocæcal invagination. Operation: resection and anastomosis. Cured.

CASE 12. Reported by Hahan. Muenchen. med. Wchnschr., 1900, ix, 288. Man, age 43, had 4 polypi in small intestine. Suffered with intestinal obstruction; no stool for 6 days. Invagination. Operation: resection of 15 centimeters of the small intestine. Cured.

CASE 13. Reported by Gross. Wein. klin. Wchnschr., 1900, xlvi, 169. Man, age 47, had submucous tumor in left half of transverse colon. Suffered with intestinal disturbances and other symptoms of tumor. Operation: enterotomy and removal of tumor. Cured.

CASE 14. Reported by Fuchsig. Wein. klin. Wchnschr., 1901, viii, 182. Man, age 47, had tumor size of walnut in ileum near ileocæcal valve. Symptoms were those of chronic ileocæcal invagination. Operation: enterotomy and removal of tumor. Cured.

CASE 15. Reported by Huss. Hygiea, June, 1884. (Quoted by Heisig.) Man, age 44, was ill for 3 years, cause not stated. Death from other cause. At autopsy, many tumors found in stomach and 12 found in intestine which were pedunculated and submucous. Size varied from a nut to a bean.

CASE 16. Reported by T. Hiller. Beitr. z. klin. Chir., 1899, xxiv, 509. Man, age 51, had lipoma size of walnut, of small intestine, originating from fat-cells between mucosa and muscularis. Patient suffered with acute colic, vomiting, rigid abdomen, and rapid pulse. Diagnosis: high intestinal obstruction. Invagination 50 centimeters long. Operation: resection, with end-to-end anastomosis. Death from peritonitis.

CASE 17. Reported by S. B. Ward. Albany M. Ann., 1904, xxv, 14. Man, age 37, had lipoma of rectum (?). Suffered with colics, slight constipation, abdominal tenderness, and occasional vomiting. Spontaneous expulsion of tumor, with cure.

CASE 18. Reported by Ward. Ibid. (Case of W. G. McDonald.) Woman, age 50, had lipoma of jejunum, 2½ x 1¼ inches. Suffered with violent abdominal pain. Loss of weight. Constipation more recently. Operation: laparotomy and removal of tumor. Cured.

(Another case of McDonald reported by Ward; no histological examination.)

CASE 19. Reported by Albrecht. Petersb. med. Wchnschr., 1880, No. 9. Sex of patient not given. Age 51. Had tumor with thin pedicle. Suffered with abdominal pains, diarrhœa. Slimy and bloody stools. Spontaneous expulsion. Result not given.

CASE 20. Reported by Link. Wien. klin. Wchnschr., 1890, No. 13. Man, age 40 (?), had pedunculated tumor of rectum protruding through anus. Palpation showed abdominal tumor. For 5 years, patient had had attacks of intestinal obstruction and hæmorrhages at times. Tenesmus for 3 years. Operation: excision per anus. Result not given.

CASE 21. Reported in St. Thomas Hospital Reports, 1899, xxviii, 60. Man, age 56, had mass in sigmoid region, which on palpation was found to be a pedunculated tumor the size of an orange. Patient suffered with constipation, rectal hæmorrhages and abdominal pains. No vomiting. Bloody and mucous stools (no fæcal matter). Operation: sigmoid opened, pedicle ligated and tumor removed. Cured.

CASE 22. Reported by Stable. St. Thomas Hospital Reports, 1894, xxiii, 115. Man, age 32, had a pedunculated tumor, which was a submucous

lipoma, about 30 inches from cæcum. It was attached opposite mesentery and caused intussusception of 8 feet of bowel. There was acute pain in lower abdomen, vomiting, and abdominal rigidity. Operation: laparotomy and reduction of intussusception. Tumor removed (?). Nine days after operation, sudden rise in temperature and signs of sepsis. Second laparotomy showed a large slough of the bowel. Ten days later, secondary hæmorrhage, and death.

CASE 23. Reported by La Garde. Progress (Louisville), 1886, i, 264. Man, age 65, had pear-shaped, pedunculated rectal tumor, 2½ x 1¾ inches. Patient had usual symptoms of rectal tumor for three years. Mucous and bloody stools. Tumor later protruded and could be palpated and seen through speculum. Operation: ligation and section of pedicle. Cured.

CASE 24. Reported by Mayo Clinic, January 20, 1905. Woman, age 62, had large tumor of sigmoid, considered to be secondary to chronic inflammation of sigmoid due to fæcoliths. Preoperative diagnosis: ovarian tumor. Some pain and other symptoms of tumor in pelvis. Operation: resection of 8 inches of sigmoid, with anastomosis. Cure. Died of another complaint in 1911.

CASE 25. Reported by Mayo Clinic, July 31, 1906. Woman, age 52, had tumor of sigmoid. Suffered with obstinate constipation and lower abdominal pain for 5 or 6 months. Stricture and diverticulitis. Fistula of cæcum. Tuberculous retroperitoneal glands. Hernia following previous operation. Gall-stones. Operation: resection of 8 inches of sigmoid. Gland removed. Cæcal fistula closed. Hernia repaired. Death 17 days after operation.

CASE 26. Reported by Mayo Clinic, June 21, 1906. Man, age 55, had lipoma of sigmoid, upper portion. Details not given. Operation: resection, with end-to-end anastomosis. Result not given.

CASE 27. Reported by Mayo Clinic, April 1, 1914. Woman, age 28, had degenerating cystic lipoma adherent to small intestine and to sigmoid; also a large, irregular pelvic mass. Patient had had subtotal hysterectomy 3 years before at another clinic. Abdominal tumor for three weeks, slowly enlarging. Slight diarrhœa. Operation: removal of tumor; excision of cervix and a portion of the pelvic mass.

CASE 28. Reported by Mayo Clinic, September 30, 1914. Man, age 56, had submucous pedunculated lipoma, size of an egg, causing intussusception, which was reduced spontaneously before operation. Patient suffered with alternating constipation and diarrhœa for 6 years. Bloody and mucous stools. Pain in left iliac fossa. Operation: resection of 10 inches of sigmoid, with end-to-end anastomosis. Cure.

CASE 29. Reported by Mayo Clinic, October 2, 1915. Woman, age 37, had pedunculated submucous lipoma, 1 x 1 x 5 centimeters, 3 inches from ileocæcal valve. Had suffered with alternating constipation and diarrhœa for 8 years. Bloody and mucous stools. Pain in left iliac fossa. (Previous operation, colotomy and short circuit.) Operation: resection of cæcum, 3 inches of ileum, appendix, ascending hepatic flexure. Anastomosis. Cure.

NOTE:—The first eight cases are taken from Heurtaux's report. Cases 1, 2, 4, and 6 also reported by Longuet (6).

ANGIOMATA

Angioma of the bowel is very rare, imperfect records of only 3 cases being found. Heurtaux tabulates these cases, but Longuet considers Case 1 doubtful. We could find no other cases, nor could Dewes (24). Lauenstein (30), however, refers to a case of Nicholl's, but the reference[1] does not give the year of publication.

ANGIOMA CASES[2]

CASE 1. Reported by Marsch,[3] after Longuet, 1898. Girl, age 10. Tumor located in rectum. Details not given.

CASE 2. Reported by Arthur Barker, after Longuet, 1898. Man, age 43. Details not given. Death from anæmia.

CASE 3. Reported by Pierre Delbet, Leçons de clin. chir., 1899. Woman, age 21, had a circumscribed tumor 3 centimeters wide (cavernous angioma) located in small intestines. There was chronic intestinal obstruction but no occlusion. Operation: laparotomy. Death.

TERATOBLASTOMA

Teratoblastomata of intestinal origin are also very rare. Longuet (6) records two cases both in females, and quotes a third case reported by Barker as a rectal tumor, but which Longuet considers to be very probably a sacral tumor, becoming adherent to the rectal wall secondarily.

TERATOBLASTOMA CASES

CASE 1. Reported by Dantzell. Arch. f. klin. Chir., p. 442; Cong. Chir. Berl., 1874, p. 341. Woman, age 25, had submucous tumor, size of an egg. Consisted of fibrous tissue with two poorly developed teeth. Details not given.

CASE 2. Reported by H. Post. Tr. Path. Soc., 1880, xxxi, 307. Woman, age 16, had thickened polypoid tumor, a teratoma containing bony tissue, skin, hair, muscle, fibers, and a canine tooth. The tumor protruded at anus, a mass of hair showing at each stool. Two short pedicles were ligated and removed. Cure.

[1] Nicholl. Brit. M. J., April 4.

[2] This table was taken from Heurtaux.

[3] Longuet does not consider this an authentic case.

NEUROFIBROMATA

Three cases are reported in which many intestinal tumors, histologically fibromata, were found in cases of generalized neurofibromatosis. There are other cases reported, but no histological examination was made. This examination in these 3 cases, however, showed nothing characteristic of neurofibromata, as no elements of nerve-tissue were found, but the most probable assumption is that they were true neurofibromata. They are certainly very different from the large, single fibromata as shown in the reported cases. An interesting point is that these tumors are frequently found in tubercular subjects; also, interesting is the fact that they are frequently found associated with sarcoma (Case 1).

NEUROFIBROMA CASES

CASE 1. Reported by Leriche, Lyon chir., 1911, vi, 70. Man, age 45, had neurofibroma located in the pylorus, also many small tumors of the intestines which were fibromata with no trace of nerve tissue. The pyloric tumor showed early sarcoma. There was pyloric obstruction, and patient also suffered from generalized neurofibromatosis and pulmonary tuberculosis. Operation: gastro-enterostomy; pylorectomy. Death two weeks later from purulent pleurisy.

CASE 2. Reported by Marie and Couvelaire. Nouveauiconog. de la salpetriere, 1900, xiii, 26. Patient had ten tumors in small intestines, two in duodenum, others in jejunum and ileum. Large intestine free. No symptoms. Generalized neurofibromatosis. Tumor found at autopsy.

CASE 3. Reported by Branca. Bull. Soc. anat. Par., 1897, lxxii, 166. Patient had many tumors springing from intestines. Details not given. Generalized neurofibromatosis. Tumor found at autopsy, the patient dying from pulmonary tuberculosis.

A résumé of these cases brings out these facts; one hundred nineteen cases of benign tumors were found, divided as follows:

Fibroma	14
Adenoma	17
Myoma	45
Lipoma	29
Angioma	3
Teratoma	2
Fibromyxoma	3
Neurofibroma	3
Rhabdomyoma (malignant)	1
Fibroadenoma	2

As regards location, they are distributed as follows:

Duodenum	5
Jejunum	8
Ileum	23
Small intestine (not designated)	11
Ileocæcal region	3
Appendix	1
Colon	22
Rectum	36
Intestine (not designated)	10

As regards the patients, we find 46 males, ranging in age from 17 to 75 years, 61 females, whose ages vary from 13 months to 83 years, and in 12 cases the sex and age are not stated.

In considering the symptoms, Heurtaux divides the cases into three groups; first, the small tumors causing no symptoms, which are found by chance at operation or autopsy; second, larger tumors growing toward the serosa and causing little or no symptoms except the pressure of a tumor; third, tumors causing intestinal disturbances, which may be (1) irritative, or (2) partial or complete obstruction. In the second class of cases, there may in some instances be an obstruction from adhesions or from the pressure of a large tumor. In the third class, the symptoms vary from vague intestinal pains, "indigestion," etc., to colicy attacks, vomiting, often obstinate constipation, which may alternate with diarrhœa. At times, true obstruction develops, which may clear up spontaneously, may be relieved by purgation and enemata, or may require operation. Some cases are characterized by a persistent diarrhœa. At times, bloody and mucoid stools are complained of, especially in the case of a rectal tumor. These latter are also characterized by tenesmus, a sensation of a foreign body in the rectum, and at times the appearance of the tumor at the anus during defæcation.

The diagnosis rests on the above symptoms, which generally appear as follows (Heurtaux):

1. Rectal tumor, which presents at anus or is felt in rectum, accompained by tenesmus, bloody stools, constipation, and sensation of a foreign body in the rectum.

2. Tumor felt on examination, with mild indefinite digestive symptoms.

3. More or less grave intestinal disorders, such as partial or complete obstruction, etc., no tumor felt (usual).

4. Similar to 3, but tumor is felt (rare).

5. Tumor only, no subjective symptoms (rare).

As can be seen from the case reports and from the tables, the most frequent complication is invagination, which occurred twelve times in Heurtaux's 50 cases (adenoma, twice; myomata, seven times; lipomata, three times), and eleven times in the additional cases collected by us. This is a rare occurrence in the case of a malignant tumor of the intestine, on account of the different mode of origin and growth of the latter. Another eventuality, in the case of pedunculated tumors (of the rectum, in particular), is spontaneous rupture of the pedicle and expulsion of the tumor. Heurtaux noted this occurrence six times (myomata, three times, and lipomata, three times).

The prognosis depends chiefly on the location of the tumor and its mode of growth, whether "internal" or into the lumen of the bowel, or "external," or toward the serosa. In other words, the prognosis depends on the effect of the tumor on intestinal function. Of course, the size of the tumor and the presence or absence of adhesions are points to be considered. The prognosis is more favorable in the case of rectal tumors than in the abdominal type. Eliminating the cases in which the tumor was found at autopsy (the patient dying from other causes), we find the following: 76 cases were operated upon, with 12 deaths; (result not given in 7); 6 cases were not operated upon with 6 deaths, due to the tumor. Thus we see clearly that the operative treatment is the method of choice in dealing with these cases.

In conclusion, I desire to express my thanks to Dr. Miller for permission to publish his case, and for his aid in securing references to the literature. I wish also to thank Dr. A. L. Levin, of New Orleans, for translating the articles of Prokopyeff and Lange from the original Russian, and Dr. Peter Graffagnino, of this city, for assistance in translating one of the Italian articles. Mr. Augustin, the assistant librarian of the local Medical Society, the librarian of the Surgeon-General's office, and Dr. Audrey Goss and W. A. Brennan of the John Crerar Library, were very courteous and obliging in many ways, and their aid is greatly appreciated. I am also under obligations to Dr. S. D. Henderson, who has kindly supplied the illustrations.

NOTE.— After this paper had gone to press, I found the following case of fibroma, which had caused intussusception; being reported under the latter heading, it had not come to our notice in our search of the literature.

Reported by Means and Forman (67). Female, white, age 37. Previous history negative, no intestinal trouble. She had been ill for 9 days, beginning with partial obstruction and attacks of colic, then developing into true intestinal obstruction. Leucocytosis was present. At operation, a recent intussusception was found, ileocolic, reaching almost to the hepatic flexure, with a pedunculated tumor at its tip. Reduction was performed, and a tumor was found in the ileum, about 10 inches from the ileocæcal valve. The intestine was opened, the pedicle ligated and the tumor removed. The intestine and the abdomen were closed as usual, the patient making an uneventful recovery.

The pathologist reported it to be an œdematous fibroma, 3.5x4x3 centimeters.

A case reported by James and Sappington (68) under a similar title has also been reported very recently. The patient was a woman, age 34, rather underdeveloped. Past history unimportant. She was seized suddenly with intense abdominal pain, felt faint and weak, and was nauseated. The pulse was slow and weak, temperature slightly subnormal, face pallid, abdomen rigid and tender. She reacted somewhat, but the tenderness and rigidity persisted. Pelvic and abdominal examinations were negative. A tentative diagnosis of ovarian cyst with twisted pedicle was made. At operation, an intussusception was found, with 55 centimeters of gangrenous, invaginated intestine; at its distal end a tumor was felt. Resection and anastomosis were performed; the patient's convalescence was fairly smooth. Pathological examination revealed a sessile, submucous tumor, 2.4x1.9x1.9 centimeters, opposite the mesenteric border. Microscopically, it was found to be a hard fibroma originating from the subserous layer.

The authors refer briefly to 24 other intestinal fibromata (most of these being included in our report); but it is necessary to refer to the original papers in order to be certain that a histological examination was made in each case; for example, of the 219 benign intestinal neoplasms collected by Dewes, only a small percentage had been examined microscopically. The additional cases mentioned by James and Sappington will be investigated and reported upon later.

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FATTY TUMORS OF THE UTERUS

With the Report of a Case and Notes On Classification

By C. W. W. ELKIN, M.D., and S. R. HAYTHORN, M.D., Pittsburgh
From the Wm. H. Singer Memorial Research Laboratory

UTERINE tumors which are characterized by being composed chiefly of fat-containing tissues are very interesting because they are still of uncertain origin. The cells which contain the fat globules have never been certainly identified and for this reason there is a great deal of confusion in the literature regarding the proper name for this type of tumor. These tumors have been called by various authors lipomata, myolipomata, and merely fatty tumors. Some have classified them as mixed tumors, under the name of lipofibromyomata, while others have referred to them simply as a type of degeneration in leiomyomata.

That these tumors occur rarely is evidenced by the fact that there have been collected, in addition to our case, only fourteen other unquestioned instances, and when we stop to consider the enormous numbers of fibroids which have been removed and sent to laboratories for examination, the relatively small number which have been found to contain fat becomes considerably emphasized.

The cases reported in the literature prior to 1903 were collected by Seydel (1) who accepted up to this time, four cases of true lipoma and a total of eleven of what he called "lipomatous tumors."

In 1906 Ellis (2) reviewed these reports and added one case of his own; an interstitial fatty tumor 8 x 6.5 centimeters, removed at autopsy from a woman aged 60. Microscopically there were seen typical lipomatous cells, round or polygonal in shape, but much larger than those of normal adipose tissue, with their nuclei flattened and crowded to one side. The capsule consisted of fibrous or fibrofatty tissue with fat cells in it, but there was little fibrous tissue in the tumor.

Sitzenfrey in 1910 (3) reported an intramural lipomyosarcoma of the anterior wall of the uterus, about the size of a small child's head, containing in its middle a fatty area 9 x 2.5 x5 centimeters. In addition, there were some myomatous nodules present with fatty infiltration and projections into the myomatous tissue. The fatty tissue was arranged as irregular masses, as diffuse and infiltrating areas, and showed the usual reaction of fat stains. In the septa and the neighboring tissues were groups of lipoblasts, many of which contained small fat droplets; the fat droplets were described as gradually passing into large fat cells.

Ley (4) described a tumor of the uterus, 12 centimeters in diameter, composed of closely set nodules 1–3 centimeters in diameter, some of which had yellow strands running through them. Microscopically there were fatty envelopes filled with fat globules separated by narrow strands of collagen fibers and muscle. Ley considered the tumor a fatty metamorphosis of fibrous stroma rather than a fibromyolipoma. His figures represent the diffuse fat as composing about one-half of the total tissues. Ley also referred to a lipoma or fibrolipoma placed in the museum of St. Bartholomew's Hospital by Sir James Paget, but without microscopic sections.

A very brief review of the cases quoted by Ellis seems advisable here: (1) Leberts (5) pictured a lobulated fibrofatty or musculofatty tumor imbedded in the uterine wall. (2) Stroinski (6), 1880, reported a lipoma existing as a polyp on the anterior lip of the cervix. (3) Orth (7), 1893, mentioned a lipomatous polyp. (4) Bruennings (8) reported, in 1899, a lipomyoma the size of a child's head in the anterior wall of the uterus of a woman of 55. (5) Franque (9), in 1901, described a lipofibromyomatous cervical polyp the size of a pigeon's egg. (6) Knox (10), in 1901, described, in detail an interstitial lipomyoma of the posterior wall of the uterus removed by hysterectomy from a woman aged 62, which measured 10x13x10 centimeters. (7 and 8) Meckel, (11 and 12), 1901, reported two cases; one of interstitial lipoma the size of a billiard

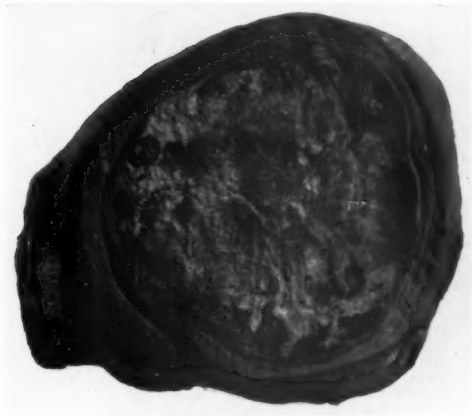

Fig. 1. Lipoma of the uterus. Cross section through the greatest convexity showing the large fatty mass in the posterior wall. The displaced uterine cavity is seen near the left of the picture.

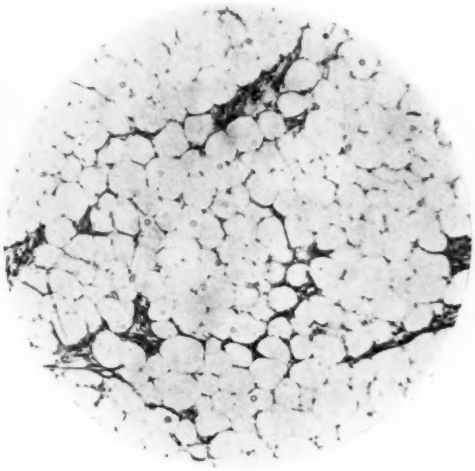

Fig. 2. Microscopic section through fatty portion of tumor.

ball; the other was a lipofibromyoma, the size of an orange, in the body of the uterus of a woman of 63. (9) Jacobson(13),1903, described a lipofibromyoma 8 centimeters in diameter in the anterior wall of the uterus of a woman 68. (10) Seydel (loc. cit.), in 1903, found a walnut-size lipofibromyoma in the uterus, as an interstitial growth of the fundus uteri, in a woman of 58. (11) Meyer (14), in commenting on Seydel's case, reports in the same paper a subserous lipoma the size of a cherry stone, in the uterine fundus of a woman of 42.

Seydel cited three other cases which he did not accept as belonging to this group, viz: Lobstein (15, cited by Meckel) in 1903 described a fatty tumor of the uterus the size of a 7–8 months' pregnancy; Seegar in 1853 reported a tumor the size of a child's head, which protruded externally and was removed by ligation of the pedicle; it was macroscopically a fatty tumor traversed by firm fibrous bands. T. Smith (16), in 1861, presented a tumor before the Pathological Society of London, pedunculated in character, the size of two fists and projecting from the fundus; it was chiefly of firm fibrous tissue; imbedded in it and easily shelled out, was a fatty tumor the size of a pigeon's egg.

Several cases reported by the older writers were believed to be instances of fatty degeneration of pre-existing tumors, usually myomata. Even this change is rare. According to McDonald (17) only seven cases, reported by various writers in five hundred and thirty cases of uterine fibromyoma, showed this change.

With the hope of offering some additional data which will aid in clearing up the question of the origin and proper classification of these tumors, we are reporting our studies on a case which occurred on the surgical service of Dr. S. V. King at the Allegheny General Hospital, together with our conclusions as to its probable histogenesis.

History. S. R., colored, single, age 46, admitted to the Allegheny General Hospital June 30, 1914, complaining of vaginal bleeding of four years' duration, with hæmorrhages occurring about once a week. Two years previously she had noticed gradual enlargement of abdomen which she attributed to pregnancy. A diagnosis of myoma of the uterus was made and abdominal hysterectomy performed July 3, 1914, by Dr. King. Recovery was uneventful.

Macroscopic description. The specimen consisted of the uterus amputated at the cervix and contained tumor masses, weighing together 4,108 grams and measuring 21 x 24 x 15 centimeters. The perimetrium was smooth, except for a few tags of adhesions. The myometrium varied from 1 to 2 centimeters in thickness. The largest part of the specimen was made up of a tumor measuring 16 x 15 centimeters in diameter, being practically spherical in shape and occupying all of

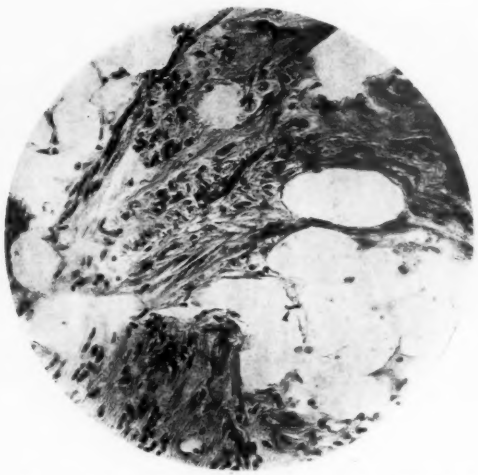

Fig. 3. Microscopic section showing smooth muscle and connective-tissue bundles running through tumor.

Fig. 4. Microscopic section showing fat cells surrounded by smooth muscle and connective-tissue masses.

the posterior wall of the uterus. This tumor mass was well demarcated and entirely encapsulated and was covered, on its intra-uterine surface, with smooth endometrium. Through its position in the posterior wall it produced an enlargement and marked distortion of the shape of the uterine cavity. In the cervical portion of the uterus were two tumors measuring 5 x 6 and 2 x 3 centimeters in diameter. They were interstitial in position and definitely separated from the large tumor. When incised the large tumor was found to be made up chiefly of a yellowish white fatty like tissue which was soft in consistency and presented irregular fibrous bands running through it. Its surface was quite greasy on palpation and lacked the laminated and striated appearance usually found in leiomyomata. With appropriate stains the tumor gave the typical characteristics of fat tissue except in the irregular strands mentioned above (see illustrations). The smaller tumors were laminated and striated, firm in consistency and failed to give fat reactions. There were a few small blood-vessels entering the tumor masses. The ovarian tubes and blood-vessels were cut off close to the uterus. There were no evidences of retrograde changes such as necroses, cyst formations or calcifications. One remarkable thing was the peculiar odor of the large tumor mass when it was incised. It was strong enough to scent the whole laboratory and was exceedingly aromatic and sweetish. It was likened to the smell of a somewhat over-ripe but not yet rotten cantaloupe.

Microscopic description. Sections taken from the various portions of the large tumor mass showed practically the same general characteristics. These consisted of irregular islands of fat cells of the adult type, which were quite large in size and had the usual flattened nuclei, some of which were vacuolated. Lying between the fat islands and the individual fat cells was seen a tissue composed of two other types of cells. One of these types was an elongated spindle-shaped cell with an oval vesicular nucleus. Stained with phosphotungstic-acid hæmatoxylin this type of cell seemed to have, for the most part, fine straight fibrils which showed a tendency to spread at the ends. It produced very little intercellular substance the fibrils of which were fine and wavy and corresponded to the collagen fibrils described by Mallory. In some of these latter areas the collagen fibrils were matted together and produced a hyaline appearance. The second chief type of cell was a long spindle cell with narrow rod-shaped nucleus and relatively coarse fibrils that tended to fuse at the ends and corresponded to the myoglia fibrils described by Mallory. Strictly speaking the relative number of cells with fibroglia fibrils appeared to outnumber the cells with myoglia fibrils. Frozen sections were made from pieces fixed in formalin and these stained poorly with Scharlach R, Sudan III., and Herxheimer's stain. This may have been due to the fact that many of the vacuoles were emptied or else that the fat existed in a somewhat different state from that readily stained by usual methods. In the gross, however, the fat tissue stained a bright red with Sudan III.

The portions containing fat were clearly outlined from those which were fat free.

Diagnosis. We believe this growth to be a typical example of the so-called lipomatous tumors of the uterus, but we admit that the correct name for it is open to argument and we are refraining from applying a name to the tumor until after a discussion of the histogenesis has been presented.

DISCUSSION

The histogenesis of lipomatous tumors of the uterus has been differently interpreted by various observers. Knox (10) considered them as supporting Conheim's embryonic cell rest theory (viz: that embryonic fat cells were left behind during development which later produced the tumors). Meckel (quoted by Ellis) thought they originated by the hyperplasia of embryonal fat. Seydel (loc. cit.) regarded them as springing from lipoblastic dislocations, because he could not demonstrate the formation of fat cells from either muscle or connective tissue. Another possibility which has been suggested is that of the ingrowth of true fat tissue along the vessels or the nerves from neighboring structures. Bruennings (8) favored the view of the change of muscle cells into fat cells. Franque and Jacobson attributed the development of the fat cells to the infiltration of connective-tissue cells by fat globules.

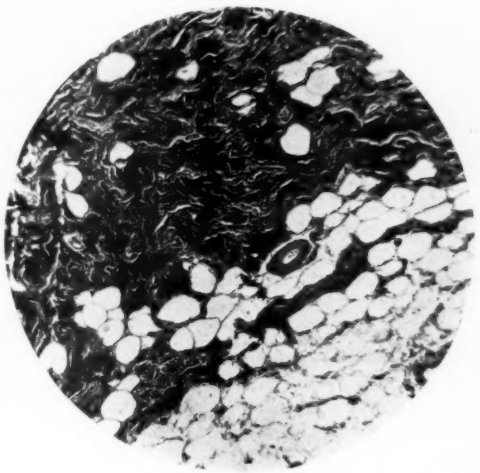

Fig. 5. Microscopic section from the junction of normal fat with a so-called fibroma of the breast showing a similar picture to that seen in Fig. 4.

The above theories fall into one of the two groups depending on whether or not the tumor cell is held to be a true fat cell arising from a lipoblast, or to be some other type of cell which has merely taken up fat. The theories of Knox and Meckel are so closely associated that they may be discussed together. Mallory (18) makes the statement that fat cells are perfectly definite cells formed by differentiation from mesenchymal cells and are neither fibroblasts nor derived from fibroblasts. R. Meyer states that embryologically no fat cells occur in the uterus, broad ligaments, or myomata. So that if we accept the views of these two authorities the cell-rest theory in the strict sense, is automatically excluded on the very obvious grounds that if such cells were at no time normally present they could not remain as rests and start to grow at a later time. On the other hand, as long as one attempts to interpret these tumors as lipomata, he must grant that they can spring only from lipoblasts and if lipoblasts are not normally present in the uterus during development they can occur only as embryonic displacements and thus Seydel's view becomes the only tenable one.

The extension along the vessels and nerves is very unlikely both because of the thick capsule and because of the constant finding of the larger vessels near the centers of connective tissue bundles and not in the fatty areas.

The whole difficulty lies in our inability to say that the large fat cells were not derived from connective-tissue cells. The fibroglia fibrils which are the only definite means of identifying connective-tissue cells could not be demonstrated in connection with fat-cells and aside from the globular fat contents we know of no characteristic structures by which to identify a fat cell, so that we could not be sure that after all we were dealing with true fat cells. We know that highly specialized cells such as heart muscle cells, striped muscle cells, liver, adrenal and glandular epithelial, etc., can and do take up fat in a globular form, and it seems reasonable to think that connective-tissue cells which are certainly less specialized may do the same thing. Many smooth muscle cells were identified by their fibrils and none was found to contain either granular or globular fat so that we feel that the histogenesis of the tumor has been narrowed down to one of two cells: true lipoblasts or connective-tissue cells. The points which favor the lipoblastic displacement theory are: (1) The chief cells are typical fat cells; their nuclei are crowded to the peripheries of the

cell; they have no characteristic fibrils and in the average single field, the tumor tissue could not be distinguished from ordinary subcutaneous fat. (2) In many areas the connective-tissue cells can be identified by their fibrils but these cells are not found to contain either fat granules or fat globules; in other words, there is no shading off of the one tissue into the other, the line of junction always being abrupt. (3) In certain instances single globular fat cells of large size are seen completely surrounded by well-developed connective tissue and smooth muscle areas, just as if they had been cut off from the fat tissue. The appeareance is identical with the fat cells so frequently seen near the margins of normal fat tissue as in the so-called fibromata of the breast. (4) All sorts of degeneration and necroses occur in leiomyomata and in at least one case we have examined, the necrotic area was filled with fat laden endothelial leukocytes and foreign body giant cells, yet we cannot recall having seen globular fat in any of these foci. (5) If the condition was due to fatty infiltration of connective-tissue cells, it should be fairly common because of the frequency of other degenerations in these growth but it has been shown that the rarity of the condition is beyond question. (6) Congenital remains and displacements of several types of tissue are relatively frequent in the female genital tract.

The points which favor the theory that the tumor forms from connective-tissue cells by fatty infiltration are: (1) Identified connective-tissue cells with typical fibrils were so closely associated with the fat cells that one hesitated to differentiate between them. (2) Infiltration of many cells by fat globules is a recognized process to which connective-tissue cells are not known to be immune. (3) The age of the patients from whom such tumors have been taken is rather beyond the usual time for the development of congenital tumors. The ages were given in eight of the quoted cases and ranged from forty-two years in the youngest to sixty-eight years in the oldest with an average age, for all eight cases, of fifty-seven years. This point has never been held as a very strong one against the cell-rest theory of cancer and we do not wish to lay too much stress upon it.

We make no claims to having settled the question in general but in our case we think that the bulk of the evidence was on the side of the lipoblastic displacement theory, and for this reason we have diagnosed our tumor as a "lipoma." We have considered the connective-tissue cells present simply as a part of the stroma and the muscle cells as accidental inclusions in the tumor and not as evidences of its having been of mixed origin.

CONCLUSIONS

1. Fatty tumors of the uterus come from one of two sources; either lipoblastic displacements or connective-tissue cells which have undergone fatty infiltration.

2. The lipoblastic displacement theory offers the best explanation of the findings in the above case.

3. Having accepted the lipoblastic displacement theory for the explanation of our tumor, we believe it to belong to the class of "simple tumors," and that it should be called a *lipoblastoma uteri*.

We wish to express our indebtedness to Dr. S. V. King of the Allegheny General Hospital of Pittsburgh, for the privilege of reporting this specimen..

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A STUDY OF ONE HUNDRED CONSECUTIVE FRACTURES OF THE SHAFTS OF BOTH BONES OF THE FOREARM WITH THE END-RESULTS IN NINTY-FIVE[1]

By ALLEN O. WHIPPLE, M.D., and FORDYCE B. ST. JOHN, M.D., New York

THE following study is based entirely upon observations of cases treated at the Presbyterian Hospital Out-Patient Department, between 1912 and 1915. The purpose throughout the series has been to improve our own methods of treatment of fractures of both bones of the forearm by a careful study of end-results. Necessarily our ideas have changed from time to time and consequently some of our methods. The essential principles in treatment, however, have been adhered to throughout the series.

ANATOMICAL FACTORS

The important mechanical factors to be borne in mind in considering fractures of the shafts of radius and ulna are: First, the action of the pronators and the supinators of the forearm, the pronators chiefly affecting the positions of the fragments in fractures of the lower half; the supinators affecting the positions of the fragments in fractures of the upper half of the shafts. Second, the relation of the radius to the wrist-joint results in its bearing the brunt of the transmitted force from hand to forearm in cases of indirect violence and explains the preponderance of displacement in the radius in these cases. Third, the question of stress and strain in relation to the frequency of fracture of the lower one-third of the radius.

UNFAIR COMPARISONS OF STATISTICS OF OPEN AND CLOSED REDUCTION

Statistics relating to the open reduction of fractures are usually based upon the work of surgeons specializing in that particular branch of surgery. Their results are compared with the inaccurate statistics of out-patient departments or emergency wards of hospitals where the fracture work is too often carried on by inexperienced internes, working alone, without the help of anæsthesia, fluoroscope, or late roentgenograms. If the same surgeons were to reduce the same type of fracture with as great care and with as many assistants to help in the immobilization as they receive in the operating-room, their end-results as to function and the time that the patient is incapacitated would be as favorable, if not more favorable, than that obtained by the open method.

We do not advocate the common methods of closed reduction; on the contrary, we condemn them as they are usually carried out. The one-man reduction without anæsthetic, without fluoroscope, and without subsequent roentgenograms; the usual methods of immobilization with poorly coapting anterior and posterior wood splints, and the continuous immobilization of the forearm for a period of four to six weeks, without the use of massage and proper active and passive motions, in such splints; these we condemn and agree with those who argue for open reduction in preference to such methods of closed reduction. The methods we have used in this series of one hundred cases differ radically from the usual methods of closed reduction in many particulars. They are not the method of any one school but are a combination of what we have found to be the best methods of several surgeons and of several points in treatment which we developed as we learned by our successes and mistakes.

TREATMENT

If any reduction is necessary, it should be done immediately. In a hospital with fluoroscopic facilities, in every case in which a diagnosis of fracture of radius and ulna has been made or suspected, the patient should have the privilege of fluoroscopic examination, first, to determine the necessity of reduction, and second, to prevent the possibility of incurring displacement from manipulation. It has been our experience that easy and complete reduction varies directly with the length of

[1]From the Department of Surgery, Columbia University, College of Physicians and Surgeons.

Fig. 1. Reduction under the fluoroscope, both in the anteroposterior and lateral planes, was successful, though not complete. Note the correction of the angular deformity at the end of two and a half years. *a*, One day before reduction; *b*, one day after reduction; *c*, 2 months after; *d*, 14 months after; *e*, 2 years 6 months after.

Fig. 1. *f*. Two years and 6 months after operation.

Fig. 2, *f*. End-result 2 years and 6 months after reduction.

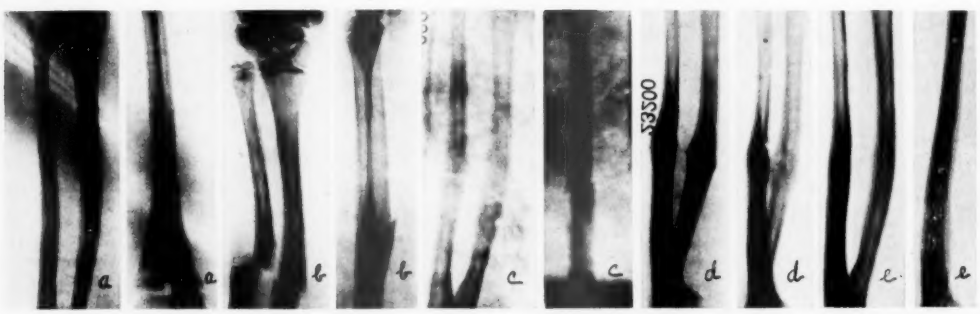


Fig. 2. Reduction after the first fracture was unnecessary. At the time of the second fracture, in order to obtain reduction it was found necessary to angulate the forearm at the site of the refracture to an acute angle. By means of this angulation it was possible to get end-on apposition and complete reduction resulted. This was done with the ends of the fragments in plain view under the fluoroscope. *a*, First fracture, no reduction; *b*, refracture after 2 months later, before reduction; *c*, after reduction; *d*, 6 months after first fracture, 4 months after second; *e*, 2 years 7 months after first fracture, 2 years 5 months after second.

time following the fracture; the earlier the reduction the easier it is and the more complete. The tissues are less traumatized and therefore repair is better. We base this conclusion upon the study of the microscopical sections of tissue removed from between the ends of fragments taken at successive stages of repair. These sections prove more conclusively than any argument the necessity for reduction at the earliest possible moment.

Anæsthesia. If reduction is found necessary, the fracture should be reduced with the patient under general anæsthesia. This provides complete muscular relaxation which is essential for reduction; it frees the patient from pain and enables the surgeon to work deliberately. The anæsthesia of choice is nitrous oxide-oxygen in patients more than six years of age; drop ether in younger children. Gas-oxygen secures sufficient muscular relaxation for purposes of reduction; the patient recovers consciousness almost immediately after reduction and is able to return to his home without the discomfort and lassitude following ether or chloroform. Moreover gas-oxygen can be given at any time and without the necessary delay of several hours after the ingestion of food. This is an important point inasmuch as the majority of patients come to the hospital soon after eating. Where one has not a gas-oxygen apparatus, nitrous oxide alone or with ether is satisfactory.

Use of fluoroscope. The chief argument put forward by the advocates of open reduction is that their work is done with the ends of the fragments in plain sight. There is no denying the advantages of reduction of a fracture with the ends of the fragments visible; and it is just this advantage that we advocate in the use of the fluoroscope for closed reduction. This point has not been sufficiently emphasized by recent writers, nor are the advantages to be gained by the use of the fluoroscope sufficiently appreciated by those doing fracture work in hospitals where fluoroscopic facilities are at hand. With the patient under general anæsthesia, satisfactory visible manipulations of the fragments, for purposes of reduction can be had by using the fluoroscope. This is especially true in children. In a number of our cases where there was marked overriding of the fragments and where full angulation of the fragments was necessary to secure end-to-end apposition, we were able to get complete reduction by producing extreme angulation of the forearm; the ends of the fragments being under visible control all the time. It is in the reduction of fractures of the radius and ulna that the fluoroscope is especially advocated because in these fractures the bones are easily seen. There are four fragments with which to deal and the assurance of good reduction, gained by palpation of the fragments, is not comparable to the combined evidence of palpation and inspection. Another very great advantage, and one that was of the utmost value to us in a number of our cases is the assurance that the fluoroscope gave us in manipulating the fragments without the fear of causing an increase in the displacement of the fragments; especially was this true in complete fracture of one bone and incomplete fracture of the other. In a great many fractures we were able to avoid increasing the displacement, or causing any displacement when we saw that the fracture was an incomplete one; but we did not hesitate to increase the displacement when by so doing we were able to get an end-to-end apposition. In this series of cases, in many of which fluoroscopic reduction was used, we have been unable to detect ill effects from injury to soft parts or from the roentgen rays. A permanent record of the reduction afforded by an X-ray plate is, of course, essential.

Importance of adequate assistance. Reduction should be carried out with ample assistance. There should be at least three men, preferably four; the surgeon, the anæsthetist, one assistant to exert traction, another to exert countertraction or assist in the manipulation. This is always insisted upon by the surgeon in doing an open reduction and the same care, exclusive of surgical technique, should be taken in the reduction by the closed method. Intelligent assistance is essential in reducing these fractures, especially at the time that the plaster splints are being applied. We heartily endorse a mechanical apparatus, such as the Hawley table.

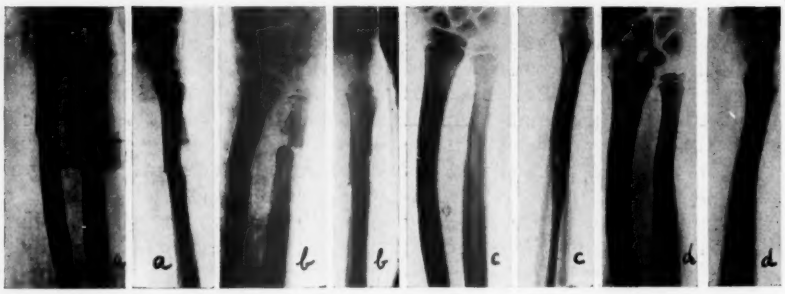


Fig. 3. Reduction in this case was obtained without the fluoroscope. The radial bowing of the radius, evident in the roentgenogram, is not seen in the contour of the forearm, nor has it affected the function in any way. *a*, One day before reduction; *b*, 24 days after reduction; *c*, 2 years after reduction; *d*, 3 years after reduction.

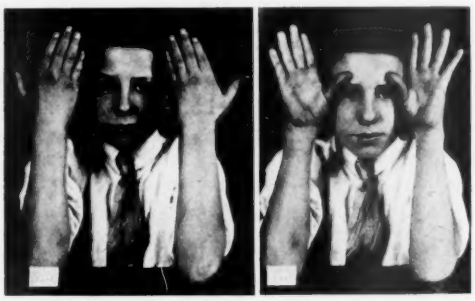


Fig. 3, *e*. Three years after reduction.

Fig. 4, *f*. Nineteen months after reduction.

Fig. 4. Reduction in this case was unsuccessful in three attempts. The displacement was increased. In this case the fluoroscope was not used, it being out of commission at the time. Notwithstanding the marked displacement the end-result was excellent. *a*, First day, first attempt; *b*, second day second attempt; *c*, third day third attempt; *d*, four months after reduction; *e*, 19 months after reduction.

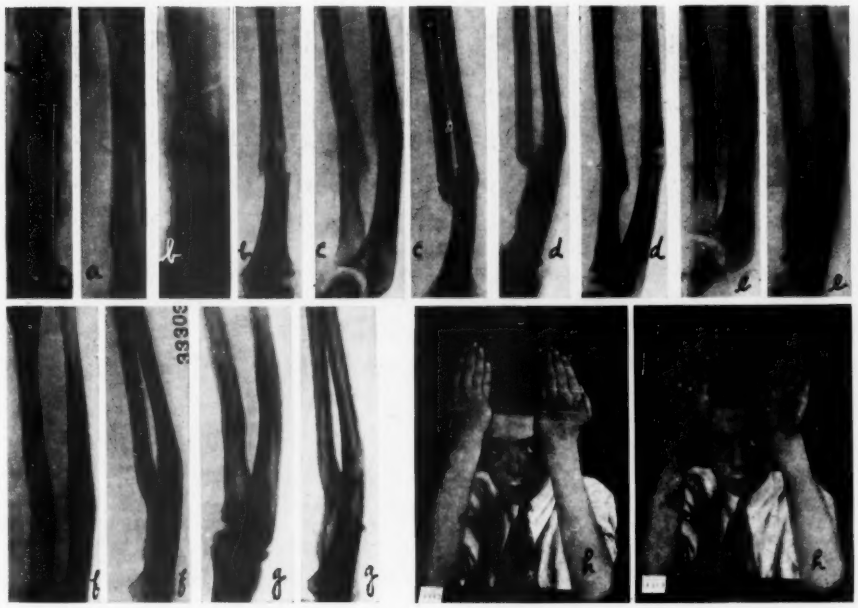


Fig. 5. Reduction in this fracture of the upper and middle thirds was unsuccessful. Notwithstanding the displacement of the fragments, the end-result was entirely satisfactory. The fluoroscope was not available for this case at the time of attempted reduction. *a*, Fracture one day old; *b*, 7 days old; *c*, 25 days old; *d*, 33 days old; *e*, 3 months old; *f*, 9 months old; *g* and *h*, 13 months old.

Every effort should be made to secure reduction at the first trial. Too often an incomplete reduction is allowed to stand, either due to the fact that the patient was not under anæsthesia or because the relative positions of the fragments could not be made out by palpation. The patient is frequently sent home to return the next day or two days later for a roentgenogram. This more often than not means a delay of three or four days, and when a second attempt at reduction is evidently necessary, the most favorable time for reduction has passed.

Positions for immobilization. The question of the position of the forearm and the best method for securing immobilization of the forearm is one that has caused an almost endless discussion and in which there is very little agreement. And in this regard, we feel its importance has been greatly exaggerated. Many of the French surgeons are loud in their praise of the position of extreme supination. Their arguments are based almost entirely on anatomical grounds, their reasoning being that the position of supination corrects the rotary displacement of the upper fragment of the radius, due to the flexing and supinating action of the biceps and supinator brevis muscles. This undoubtedly holds true in the fractures of the upper third of the forearm, especially where there is overriding of the upper fragment of the radius. But we do not think that this holds true in the other sites. Our procedure consequently varies with the site and the presence of overriding. If the fracture is in the upper third, we immobilize the forearm in supination and flexion beyond the right angle. If the fracture is in any other site, we immobilize in the position of midpronation and supination and flexion beyond the right angle. This is very comfortable and has given us uniformly good results. It must be said that the position of extreme supination for any length of time increases the discomfort of the patient considerably.

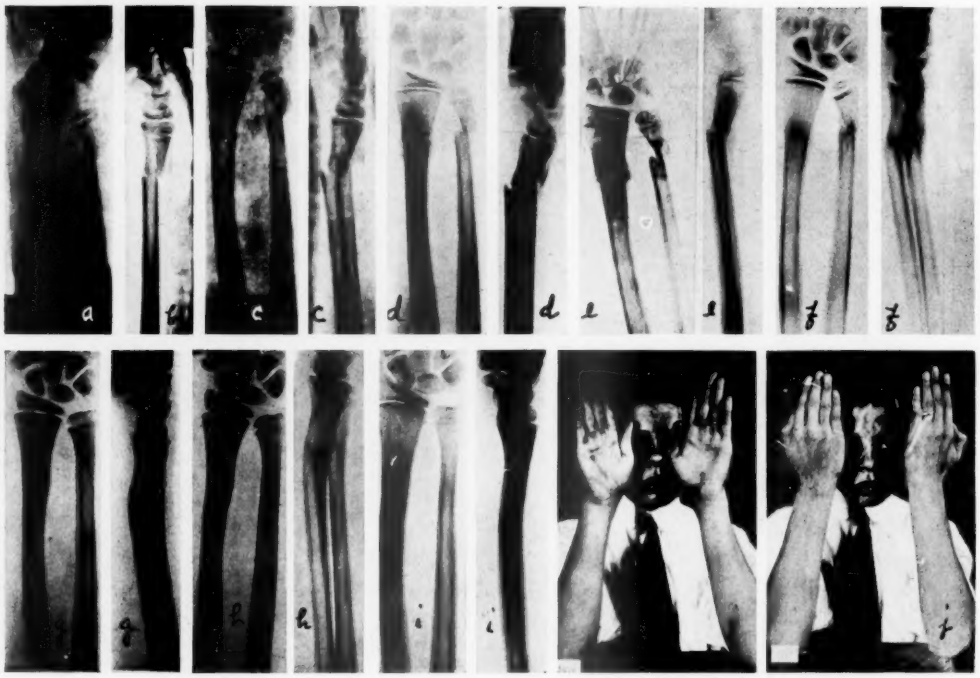


Fig. 6. The deformity was increased in this case notwithstanding three attempts with the fluoroscope. The final roentgenograms are of interest in showing the correction of the deformity. The end-result as regards contour and function was entirely satisfactory. *a*, First day after first attempt at reduction with fluoroscope; *b*, third day after third attempt; *f*, 9 weeks after third attempt; *g*, 9 months after; *h*, 10 months after; *i* and *j*, 1 year 9 months after reduction.

Method of immobilization. Our method varies with the site of the fracture, and is determined by the same reasons that were mentioned above. For fractures of the upper third, we have found that a circular plaster extending from the middle of the arm to the knuckles applied with the forearm in supination and in flexion less than a right angle gives the best immobilization. For all other fractures of the forearm, we have found the best appliance to be the so-called "sugar tong" plaster splint. This splint so far as we have been able to discover was first used in the House of Relief (Hudson Street) Dispensary. The splint, seen in Figure 11, is made as follows:

A strip of canton flannel is cut equal in length to the distance from the metacarpophalangeal joints on the palm of the hand around the forearm including the elbow to the knuckles, this measurement being taken with the elbow at a right angle and including the epicondyles of the humerus. Plaster of Paris is rolled into a strip an inch shorter than the flannel strip. The plaster strip is then laid over the dry canton flannel strip leaving the flannel side out to come in contact with the skin of the patient. The splint is then applied to the forearm, after reduction of the fracture, with the forearm held in semi-pronation and supination and with the elbow held at slightly less than a right angle. The splint is then bandaged snugly to the forearm while the plaster is still soft and it is left bandaged in this way for fifteen or twenty minutes until the plaster is set and hardened, when the bandage is cut down and a looser bandage is applied. The forearm is then supported in a sling and the patient is radiographed and sent home to report always the next day or sooner if he notices any pain or swelling or numbness of the hand or fingers. The splint should never interfere with making a fist. Tight bandaging cannot be guarded against too carefully.

The advantages of this splint are obvious. Its chief merit is the fact that rotation of the

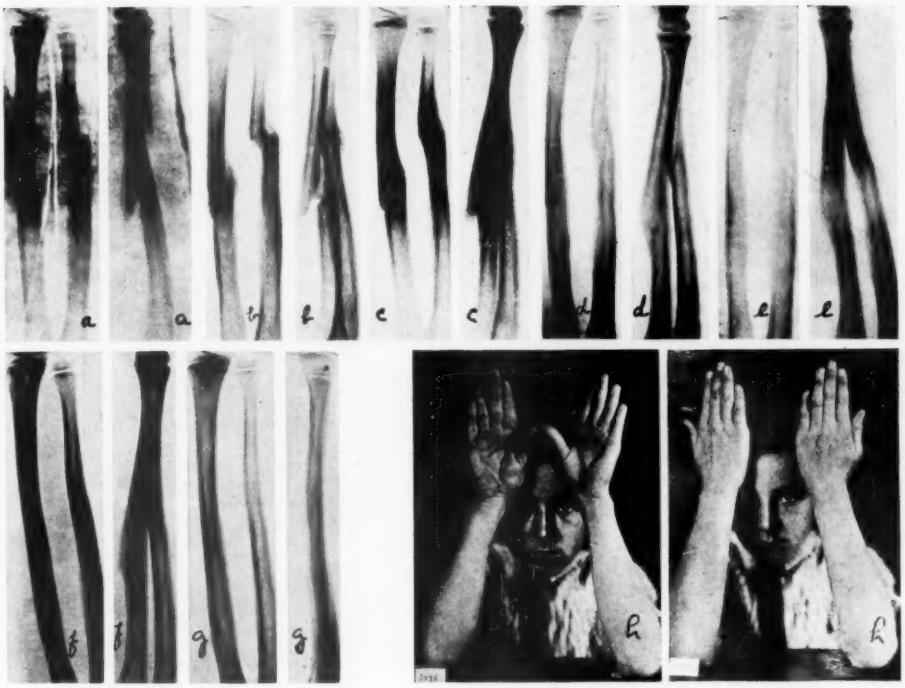


Fig. 7. This case is of unusual interest in showing the end-result of an unreduced fracture. Note the remarkable restoration of the contour of the radius and ulna and the disappearance of the spike on the upper end of the lower fragment of the radius. The end-result is normal contour, normal function. *a*, third day after second attempt at reduction without fluoroscope; *b*, 1 month after reduction; *c*, 3 months after reduction; *f*, 2 years 2 months after reduction; *g* and *h*, end-result 3 years after reduction.

forearm is efficiently prevented and the failure to do this is the one unpardonable fault of the anterior and posterior splints, especially the wood ones, which are so commonly used; at the same time a certain amount of flexion and extension at the elbow is possible. Another advantage is that small pressure pads can be applied on either side of the forearm without disturbing the splint. In passing we would say that we have used this pressure padding to very great advantage during the "sticky stage" in correcting bowing of the fragments where it has persisted after reduction. The splint is very easily removed and replaced. The only precaution that we would emphasize in the use of this splint is the importance of making sure that the splint is wide enough and that the lower borders of the splint when applied are close together, to prevent the forearm from sagging between the lower edges of the splint.

AFTER-TREATMENT

Treatment after reduction consists in baking, massage, and active and passive motions. For the first three or four days the patient is asked to return to the clinic every day for inspection of the forearm and splint. Depending upon the fracture, the dorsal portion of the splint may be lifted and the dorsum of the arm massaged very lightly and then while the elbow rests in a vertical position on a table with the forearm firmly held to the dorsal part of the splint, the ventral portion of splint may be held aside and the ventral portion of the forearm lightly massaged; after which the splint is bandaged in position. If there is continued pain and swell-

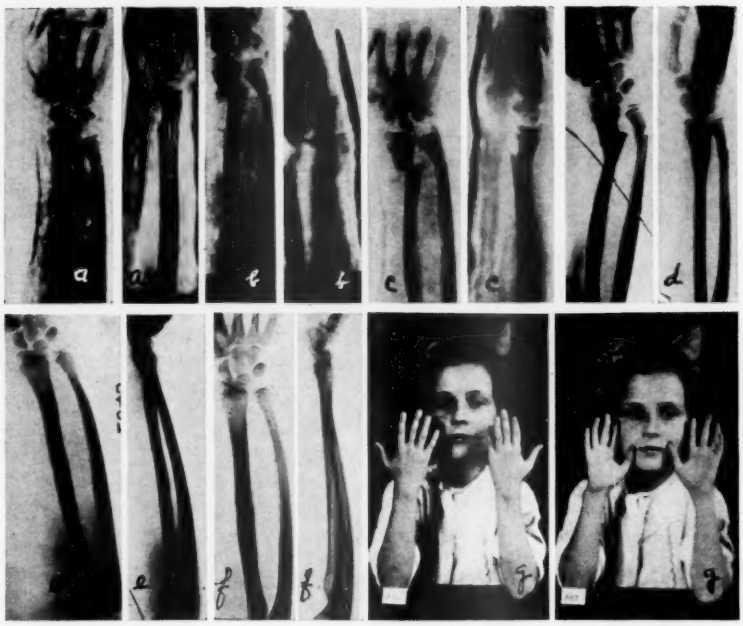


Fig. 8. Another demonstration of repair in an unreduced fracture. The roentgenograms are the best comment on the final result. *a*, First day; *b*, second attempt; *c*, 7 days; *d*, 22 days; *e*, 1 year; *f* and *g*, 2 years 2 months.

ing in the forearm after massage the forearm is baked for forty minutes to an hour at a temperature of from 300 to 350°. The baking is repeated every day until the swelling has decreased. This we found indicated only in a few cases. Patients are urged to move the fingers at frequent intervals from the first day. Repeated daily active motions of the fingers keep up the muscle tone of the forearm and hasten recovery of function.

During the second and third week depending upon the fracture, active and very gentle passive motions of rotation are used for five to ten minutes, after massage. We wish to voice our protest with that of so many surgeons against the forced passive movements, which are so often given by the masseurs and their pupils in the massage departments connected with fracture clinics. These passive movements that cause the patient pain and muscular spasm do far more harm than good, and should never be allowed even in the cases where there seems to be a delay in the return of rotation.

In many of the fractures, especially the incomplete ones, there is no doubt that the splints can be discarded after three weeks. But it has been our experience that it is advisable to leave the splints on for a period of at least four or five weeks or until the union has become solid. This is of great importance in active children, for if the splints are removed too soon, the chances of refracture are markedly increased; in our series six refractures occurred. The removal of the plaster splint and placing of the forearm in a sling is not a safeguard against refracture, for if the child falls in the prone position, the chances are that refracture will occur by direct violence.

CASE RECORDS AND FOLLOW-UP NOTES

In working up a series of any type of fracture, at the very beginning, complete history taking, notes of the examination and treat-

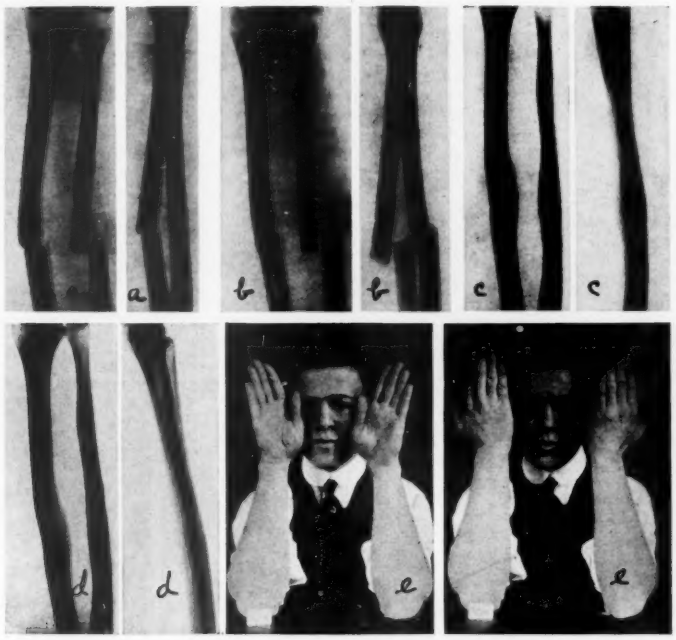


Fig. 9. After three unsuccessful attempts at reduction without the fluoroscope, open reduction was advised and performed by Dr. Joseph A. Blake. The fragments were reduced and immobilization was done without insertion of any foreign body. The result is normal contour, normal function. This is the only open reduction in the series of 100 cases. *a*, First day; *b*, seventh day after three attempts without fluoroscope; *c*, 11 months after open reduction; *d*, *e*, three years after.

ment, and subsequent follow-up notes regarding repair and function are absolutely necessary for the history analyses. Certain precautions we found very important in our follow-up work. These are:

a. Correct recording of patient's name, address, with floor, front or back, east or west, north or south (in tenement work).

b. Obtaining the number and district of public school.

c. Obtaining the name and permanent address of at least one friend outside of immediate family.

d. Taking a very personal interest in the patient as well as in his or her lesion.

e. Never allowing too long intervals to elapse without some sort of communication with patient.

f. Obtaining the co-operation of an enthusiastic, persistent, and intelligent social service worker.

CONCLUSION

In drawing conclusions from this series we wish to emphasize the fact that the majority of our cases were in children. These conclusions are based upon end-results, averaging eighteen months, in 95 per cent of our series of one hundred cases.

1. Using the end-result as the standard, open reduction for fracture of both bones of the forearm in children is unnecessary.

2. Reduction should be done at the earliest possible time. To "wait for the swelling to go down" is bad surgical practice because it is ignoring a cardinal principle of the repair of wounds in bone as well as in soft parts.

3. Fluoroscopic examination should be used to determine the necessity for reduction and to insure the best reduction with the least trauma. Every hospital where fractures are treated should be equipped with good fluoroscopic facilities and a radiographer should be on emergency call to supervise the fluoro-

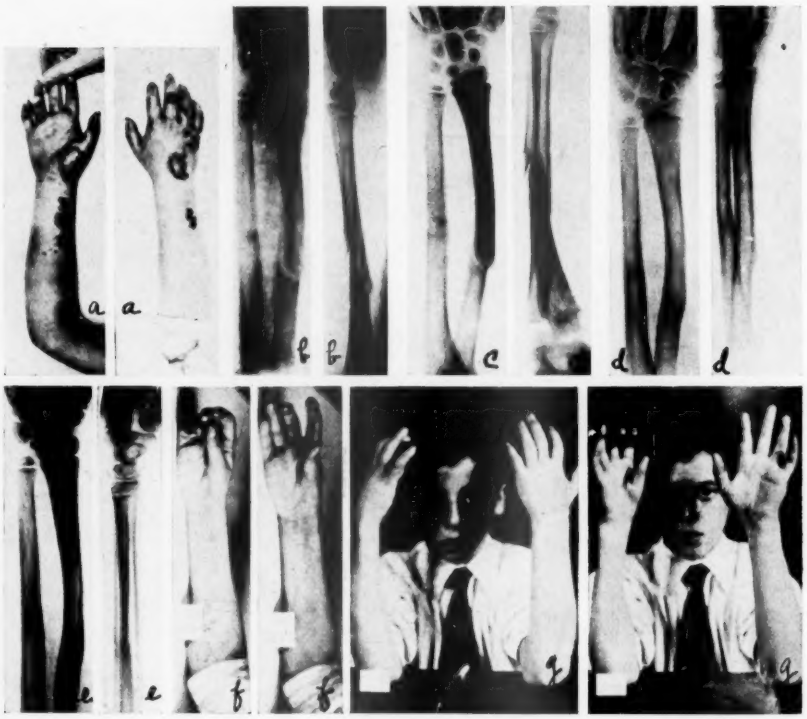


Fig. 10. The only case of ischæmic contracture in the series. The boy came to the Presbyterian Hospital 48 hours after the application of a tight anterior posterior padded wood splint by a druggist. After several weeks of treatment with baking and massage the patient disappeared. He was later operated upon by Dr. Leo Buerger, of the Mt. Sinai Hospital, and the result as shown in the photograph is unusually satisfactory for plastic repair of these cases. *a*, Forty-eight hours after fracture and removal of splints; *b*, roentgenogram 48 hours after fracture; *c*, 17 days old; *d*, 14 months old; *e*, 27 months old; *f*, limits of active movements 14 months after operation, 27 months after injury; *g*, 27 months after injury.

scopic and radiographic work on cases coming in at night or on Sundays and holidays.

4. Reduction and immobilization should be done with the patient under general anæsthesia.

5. Adequate assistance is as essential to successful and accurate closed reduction as it is in the open method.

6. Immobilization should prevent rotation of the forearm. The position of midpronation and midsupination is entirely satisfactory and comfortable except in fractures of the upper third, where full supination with the elbow in flexion is advisable.

7. Early gentle massage and active motions are advocated, but should be done under the direct supervision of the surgeon. Forced passive motions, which cause the patient pain, cannot be too strongly condemned.

8. It is essential in working up any fracture series to conduct careful history analyses.

9. Practically all cases of fractures of both bones of the forearm in children (uncomplicated by extensive trauma due to compound fractures and resultant infection) will have very satisfactory results, anatomically and functionally, with conservative treatment.

We wish to express our sincere thanks to Mr. Ira L. Simms, radiographer, and to Mr. Carlis J. Lander, photographer, of the Presbyterian Hospital for their co-operation in recording the results of this work.

TABLE I.—CONTOUR OF FOREARM

Function of Forearm	Normal	Excellent	Fair	Bad	
Normal	82	6	0	0	88
Excellent	3	1	0	0	4
Fair	0	0	2	0	2
Bad	0	1	0	0	1
	85	8	2	0	95

Of the 82 normal results the question of reduction was noted in..... 74
Of these 74 cases reduction was considered necessary in 51 cases, unnecessary in..... 23
In the 51 cases, reduction was accomplished in..... 20
Reduction was partially accomplished in..... 12
Reduction was unsuccessful in..... 13
Displacement was increased in..... 6

TABLE II.—REPORT OF THE COMMITTEE OF THE BRITISH MEDICAL ASSOCIATION. NON-OPERATIVE TREATMENT OF FRACTURE OF THE SHAFTS OF RADIUS AND ULNA.

Age Group	Number of Cases	Anatomical Result			Functional Result			Good Anatomically Good Functionally
		Good	Fair	Bad	Good	Fair	Bad	Per Cent
0–10	29	18	5	6	21	4	4	63
11–15	25	16	8	1	13	11	1	52
16–20	6	1	4	1	3	2	1	16.6
21–25	2	1	1	0	1	1	0	50
Totals	62	36	18	8	38	18	6	58

The only series that we have been able to find in which the end-results in fractures of both bones of the forearm are carefully recorded is that reported by the committee of the British Medical Association. This committee reported the results of a very careful investigation in *The British Medical Journal* (1912, vol. ii, p. 1505). We compare this table with a similar one tabulating our end-results.

END-RESULTS OF NON-OPERATIVE TREATMENT OF FRACTURE OF THE SHAFTS OF RADIUS AND ULNA IN THE PRESBYTERIAN HOSPITAL SERIES.

Age Group	Number of Cases	Anatomical Result			Functional Result			Good Anatomically Good Functionally
		Good	Fair	Bad	Good	Fair	Bad	Per Cent
0–10	51	50	1	0	50	0	1	98
11–15	35	35	0	0	35	0	0	100
16–20	5	5	0	0	5	0	0	100
21–25	2	1	1	0	1	0	1	50
Totals	93	91	2	0	91	0	2	97.8

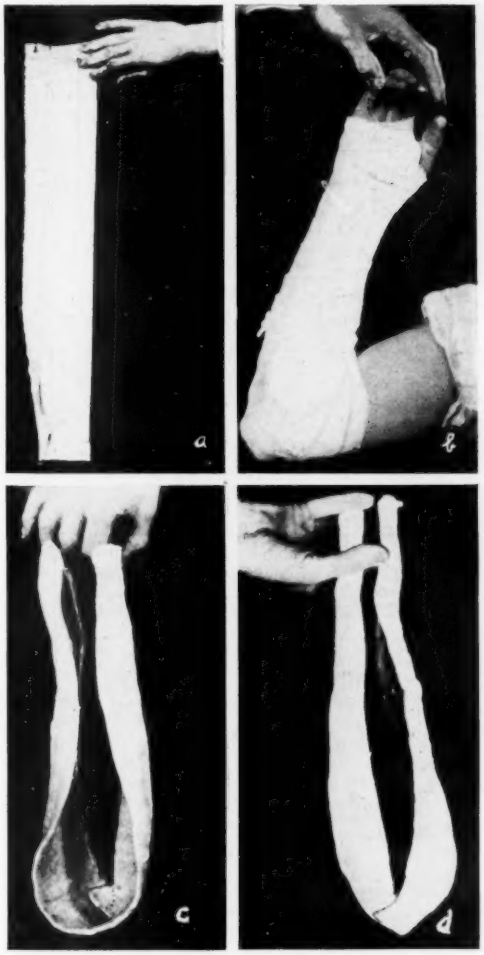


Fig. 11. *a*. Shows the plaster strip with one of the flannel edges turned over, the other still flat. *b*. Shows the sugar tong as it appears when bandaged to the forearm. Note the position of the elbow in flexion beyond a right angle, the forearm in midpronation and midsupination. *c*. The splint removed. Note the greater approximation of the inferior or ulnar margins as compared with the superior or radial margins.

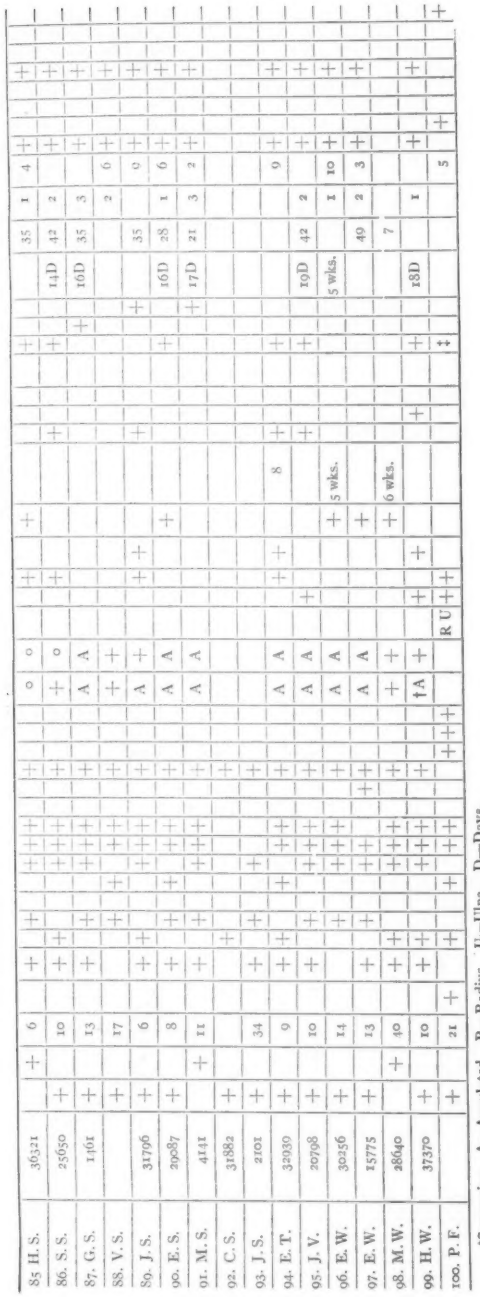
TABLE III.

Name	History	Sex		Age	Mechanism		Pathology																		Treatment																End-Results									
							Side		Site 1/3			Type						Displacement					Overriding	Anæsthesia				Reduction					Splint			Massage Baking	Time Treated	Time		Anatomical Contour				Function of Forearm			
		M	F		Direct	Indirect	R	L	U	M	L	Complete		Incomplete		Simple	Compound	Complete		Incomplete			Gas	Ether	Fluoroscope	Not necessary	Time (Hrs.)	Accomplished	Partial	Unsuccessful	Displacement Increased	Sugartong	Ant. Post.	Circular			Years	Months	Normal	Excellent	Fair	Bad	Normal	Excellent	Fair	Bad
												R	U	R	U			R	U	R	U																										
1. W. B.	37354	+		13		+		+			+	+			+	+				+	o		+				24		+			+			12D	26		5	+				+			
2. H. B.	6269		+	4	+		+			+		+	+			+				+	+			+								+			15D	22	3			+			+			
3. E. B.	4072	+		14		+		+		+		+	+			+				+	+		+	+	+		24	+				+			15D	37		7	+				+			
4. P. B.	26509	+		5		+		+		+		+	+			+				o	o					+	16 D					+			16D	42		6	+				+			
5. L. B.	2711	+		15		+		+			+	+	+			+				+	+		+				29		+			+			24D	49	2	6		+			+			
6. B. B.	38900		+	15		+		+			+	+	+			+				+	o		+				24			+	+	+					1		+				+			
7. L. B.	11909	+		8		+		+			+	+	+					+	+			R	+	+	+		24	+							14D	49	2	6	+				+			
8. A. B.	1088	+		9	+			+			+	+	+			+		+			+	R		+			24			+	+		+		36D	56		6		+			+			
9. S. B.	16055	+		10		+		+			+	+	+			+				A	A		+				72	+					+		10D	28		11	+				+			
10. E. B.	37941		+	10		+		+			+	+	+			+		+	+			R		+	+		84	+				+			13D		1		+				+			
11. M. C.			+	2			+				+			+	+	+				o	o					+																				
12. K. C.	37278		+	10		+	+			+		+			+	+				o	o			+	+	+	24					+			14D	14	1	2	+				+			
13. R. C.	37182	+		8		+	+				+	+	+			+		+			o	R		+	+		24		+			+			12D	28		6	+				+			
14. E. C.	38164	+		17		+		+			+	+	+			+				A	A		+							+		+			14D		1	3	+				+			
15. D. D.	25911	+		13		+	+				+	+			+	+				+	o		+		+		24		+			+			17D	35	2	9	+				+			
16. J. D.	11615		+	13	+		+			+				+	+	+				o	o		+		+	+							+		4D	35	2	8	+				+			
17. Refracture in 9 wks.			+	13	+		+			+		+	+			+				+	+			+	+		24	+						+	20D	35	2	6	+				+			
18. J. D.	39225	+		13		+		+	+			+	+			+		+		+	+	R	+	+	+		24			+	+	+			28D	56	1	1	+				+			
19. W. D.	1337	+		9	+			+			+	+	+			+			+	+		U	+				24		+				+		28D	42	3	1	+				+			
20. C. D.	16218	+		11	+		+			R	U	+	+			+		+		+	+	R	+	+			48			+			+			49	2	6	+				+			
21. E. D.	34587	+		14		+		+		+		+	+			+			+	+				+			24								21D	49	1	7	+				+			
22. Refracture in 3 mos.		+		14				+		+		+	+			+			+	+			+		+		24					+			21D	50	1	4		+			+			
23. J. E.	29155	+		6	+		+			+		+	+			+				o	o				+	+						+				28	1	3	+				+			
24. C. E.	19274		+	12		+		+		+		+			+	+				+	o					+						+				28		6	+				+			
25. F. E.	36024		+	10		+	+			+		+	+			+		+			+		+				24			+		+			17D	21		6	+				+			
26. G. E.	28200	+		8	+			+		+		+	+			+		+			+	R	+	+	+		24		+			+			20D	42	1	8	+				+			

| | | |

TABLE III—*continued.*

Name	History	Sex		Age	Mechanism		Pathology																			Treatment																				End-Results									
							Side		Site ⅓			Type						Displacement					Overriding	Anæsthesia			Reduction					Splint			Massage Baking	Time Treated	Time		Anatomical Contour				Function of Forearm									
		M	F		Direct	Indirect	R	L	U	M	L	Complete		Incomplete		Simple	Compound	Complete		Incomplete			Gas	Ether	Fluoroscope	Not necessary	Time (Hrs.)	Accomplished	Partial	Unsuccessful	Displacement Increased	Sugartong	Ant. Post.	Circular			Years	Months	Normal	Excellent	Fair	Bad	Normal	Excellent	Fair	Bad									
												R	U	R	U			R	U	R	U																																	
60. Refracture 6 mos.			+	6	+		+			+		+	+			+				+	+			+	+		24	+				+			15D	35	1		+				+												
61. W. McE.	13838	+		15	+			+		+		+	+			+		+	+			R U	+		+									22D	77	1	8	+				+												
62. P. McK.	18967	+		14	+			+			+	+	+		+	+				A	A		+	+	+		24		+				+		12D	49	2	3	+				+												
63. S. M.	18531		+	8	+			+		+	+	+	+			+				+	A			+	+					+	+	+			56	2	2	+				+												
64. L. M.	23848		+	13		+	+			+	+	+	+			+				A	o		+				6 wks.		+			+			30D		1	11	+				+												
65. P. M.	9415	+		4		+		+		+				+	+	+				A	A						24					+		+	14D		2	9	+				+												
66. Refracture at 9 Mos.		+		5		+		+		+		+	+			+				A	A						4 wks.										2			+				+												
67. J. M.	26492	+		2			+		+			+	+			+				A	A					+	24					+			28		2	5	+				+												
68. T. M.	40942	+		16				+			+	+	+			+				A	+					+						+			28	1			+				+												
69. B. M.	18737	+		7		+		+			+	+	+			+		+			A	R	+	+	† †		4D	+	+	+		+			20D	35	2	6	+				+												
70. W. M.	37687	+		9		+	+		+			+			+	+		+			A	R		+	+		24			+		+			18D	49	1		+				+												
71. P. M.	25030		+	4		+	+	+						+	+	+				+	A					+	24					+			24D	24		6	+				+												
72. A. M.	38163	+		9		+	+			+	+	+	+			+				+	+		+				24		+			+			13D		1		+				+												
73. W. M.	18338	+		8		+		+		+	+	+	+			+				† A	† A		+			+	24					+			18D	28	1	2	+				+												
74. P. N.	40860	+		13				+			+	+	+			+				A	A		+				24		+			+			18D	28		10	+				+												
75. J. N.	845		+	8		+		+		+				+	+	+				o	o					+	48						+		26D	28	3		+				+												
76. E. O'C.	35825	+		11		+	+			+		+	+			+				A	A			+	+		24			+		+			19D	56	1	1	+				+												
77. S. O.	37369		+	56		+		+			+	+	+			+		+	+			R U	+	+	† +		48 24		+			+				28	1	2			+				+												
78. J. O'L.	3336	+		9	+			+		+		+	+			+				A	+					+	24					+		+	14D	49	3		+				+												
79. G. P.	20020	+		14		+		+			+	+	+		+	+				+	A		+	+	+		24					+			17D			1	+					+												
80. Refracture 1 mo.		+		14		+		+			+	+	+			+				+	+			+	+		24					+						9	+			+												
81. B. P.	26428	+		2				+	R	U				+	+	+				+	+						24					+				42		9	+			+												
82. J. R.	8032	+		14	+			+	R	U		+	+			+				A	A		+	+	+		24	+				+			12D	28	1	3	+					+												
83. J. R.	30303	+		14	+			+		+		+	+			+				A†	+			+			24		+			+					1	4		+				+												
84. L. S.	17506		+	12		+	+			+		+	+			+				A	A					+	2 wks.					+			16D	35	2	3	+				+												



‡Suspension. A—Angulated. R—Radius. U—Ulna. D—Days.

SUMMARY OF THE DETAILED ANALYSIS

TABLE III

Sex —
Males, 74; females 26.

Average age —
11 years.

Mechanism —
Direct trauma in 33; indirect trauma in 56; undetermined 11.

Side of injury —
Right 40; left 60.

Site —
Upper third: radius and ulna 5; radius 2; ulna 1.
Middle third: radius and ulna 41; radius 2; ulna 2.
Lower third: radius and ulna 49; ulna 1.

Type —

Complete of radius and ulna	74
Incomplete of radius and ulna	8
Complete of radius and incomplete of ulna	14
Complete of ulna and incomplete of radius	1
Undetermined	3

Simple fractures 98. Compound fractures 2. Refractures 6.

Displacement —

Complete of radius and ulna	6
Incomplete of radius and ulna	50
None of radius and ulna	14
Complete of radius and incomplete of ulna	10
Complete of ulna and incomplete of radius	5
Complete of radius and none of ulna	1
Complete of ulna and none of radius	0

Overriding —

Of radius and ulna (all in the middle third)	4
Of radius alone	10
Of ulna alone	3

Anæsthesia —

Nitrous oxide	41
Ether	37

Fluoroscope was used in 33 cases. (It would have been used as a routine but for the fact that the machine was unavailable in the first part of this work.)

Reduction —
Closed, 99; open, 1.
Not necessary in 30. Reduction was accomplished in 22; partially accomplished in 15; unsuccessful in 20; displacement was increased in 8. The average time when reduction was attempted was 30 hours after injury, largely due to the fact that the cases were not seen until the day after the injury.
The average time under treatment was 5 weeks.

End-results obtained in 95 cases —
(Average time that the patient was followed for the end-result was 18 months. The longest time was 38 months, the shortest time with a normal end-result was 5 months.)

Anatomical Result —

Normal contour	85
Excellent contour	8
Fair contour	2
Bad contour	0
	95

Functional Result —

Normal function	88
Excellent function	4
Fair function	2
Bad function	1
	95

CARDIOLYSIS

A Further Report, with Notes upon an Additional Case

By JOHN E. SUMMERS, M.D., Omaha, Nebraska

FOUR years ago at the Cincinnati meeting of this Association, I presented a paper entitled, "Boning of the Thoracic Precordial Wall in Certain Affections of the Heart; Report of a Case;" the case being one of mediastinopericarditis treated by cardiolysis after the suggestion of Brauer. In introducing the subject I remarked that this procedure, cardiolysis or pericardiac thoracolysis, has found no favor in America; why this is so, is incomprehensible to me because the operation is based upon good mechanical principles, is not difficult of execution, neither has it a high mortality. The danger of the procedure is so inconsiderable in proportion to the good to be expected that every physician should familiarize himself with the diagnosis of the conditions calling for the operation, and every surgeon should, in addition to this, learn the technique. Let me briefly recapitulate the history of cardiolysis and the indications and contra-indications for the procedure.

In pericarditis, according to Brauer, whenever the heart becomes adherent to the pericardium, and the pericardium to the mediastinum, pleura, and chest wall, a great burden is added to the function of the organ. In systole it tugs against the bony chest, every beat being a strain upon its musculature; but the more evident the sign of tugging, the better the condition of the heart muscle, and the more surely will relief come to it if the overlying, bony wall is removed, changing it "into a movable elastic wall formed solely by musculocutaneous flaps." Internal adhesions of the pericardium to the heart may not of themselves be of great moment, and usually are difficult to diagnose, but if with their occurrence the pericardium itself becomes adherent to neighboring organs, as the mediastinum, diaphragm, sternochondrocostal wall, the function of the heart will be interfered with in degree comparable with the elasticity of these adhesions. The chest wall itself, except in the intercostal spaces, yields scarcely any at all; consequently, the heart muscle gradually becomes weaker and weaker as a result of the strain. It is in this latter condition, before the heart muscle itself is worn out, as evidenced by damming-back symptoms, that Brauer proposes the operation of cardiolysis, or, as I, in my paper, called it, "boning of the precordial wall."

Brauer postulated that for the success of the operation the following conditions must be present; diastolic shock, systolic retraction at the apex, and the ability of the heart muscle to compensate. If from myofibrosis, myocardial degeneration, or from valvular disease, the heart is unable to compensate, the operation will be futile. If threatened heart insufficiency is not too marked, if the liver is not too large and ascites too great, much relief may be expected. But above all, the patient must be one whose heart still responds to medication and relief from all strain; this in itself, is proof that there is still tone in the heart muscle, and that it will be markedly benefited by untethering its fastenings to the chondrocostal chest wall. Hearts weaker than this will scarcely be benefited by operation, and will tend to bring any operative procedure into disrepute. "Anatomically and to a lesser extent clinically, pericarditis may be divided into the following types: diaphragmatic, pleural, chondrocostal and mediastinopericarditis. The cases may be said almost never to be of the pure type. The existence of the chondrocostal type is necessary if we are to expect anything from operative interference. The heart is hitched fore and aft to the chest wall and to the vertebral column, by involvement of pleura, pericardium, and posterior mediastinum. It is at this double pull that our therapy is directed. Another indication for removal of the precordial chest wall is brought forward by Morrison. In a patient with cor bovinum

from mitral and aortic diseases, who suffered from frequent and severe anginoid pains that resisted treatment, he removed 4½ inches and 5½ inches of the fifth and sixth ribs, respectively. The result was subjectively and objectively gratifying, so that the patient was able to earn his living, which he had previously been unable to do. He was reported much improved one and one-half years after the operation. As indicated above, the principal diagnostic signs of adhesive pericarditis are systolic retraction at the apex, the diastolic shock, epigastric diaphragmatic tugging, Broadbent's sign, and cardiac and pulmonary immobility. For a more complete exposition of this subject I will refer you to my former paper, and likewise to a paper by Dr. Arthur D. Dunn and myself, on mediastino-pericarditis, published in the *American Journal of the Medical Sciences*, January, 1913.

My chief object today, is to report the subsequent history of the patient operated upon in March, 1912, and also to refer briefly to a second case and report the result.

It may be recalled that my first patient, a young man 29 years of age, presented clinically all the symptoms which I have said were essential to the diagnosis of mediastinopericarditis. In addition, he could not lie down without several pillows under him, spent his nights largely in a chair; he was unable to move without choking and coughing; could eat but little, the abdomen was distended, the bowels would not move without a cathartic, the urine was scanty and highly colored, sharply acid, specific gravity 1,030, albumin present, sugar absent; scrotum, thighs, legs and feet were moderately œdematous. Hyaline and granular casts and red blood-cells were quite numerous. The patient was placed in the Clarkson Hospital, where in the course of three weeks, compensation was restored; the heart action became regular, the murmur entirely disappeared, and the heart sounds became clear. The patient's temperature was normal throughout the entire time. After a further delay of ten days, the cardinal essential for the success of the operation, i.e., compensation, having been brought about by rest and medicinal treatment, cardiolysis was performed. At the time of my report, nine months after operation, the man was free from all the distressing symptoms for the relief of which the operation was done, and continued so, with several slight remissions (attacks of decompensation), able to perform his work as a florist, until this fall. After the work of the summer, a severe attack of decompensation made it necessary for him to stop work, and he again entered the hospital under the care of his physician, Dr. Dunn. Notwithstanding rest and proper medicinal treatment, after a stay of several months in the hospital, the man died, four years and ten months after operation. The postmortem examination disclosed the following:

The usual fixation of the pericardium, in a broad mediastinal pericarditis. No adhesions between the pericardium and the epicardium; the latter over the left ventricle much thickened, however, indicating possible early adhesions to the pericardium. The heart itself very much enlarged; walls thickened; all valves normal and competent. No change in the coronary arteries or in the aorta.

Microscopical examination. (1) *Heart.* Greater part of myocardium normal, except for possible slight increase of interstitial connective tissue. Occasional hæmorrhage, which may have occurred in the course of removal of specimen. Here and there in the myocardium are areas of what are apparently degenerated portions of heart muscle; in these the muscle cells stain more faintly than normal; they are much swollen; the cytoplasm is granular; the nuclei irregular and fragmented. More extreme stages of the same process show, in addition, loss of cellular tissue and capillaries. As a rule these changes involve distinct, fairly large areas of myocardium, but here and there can be seen single muscle fibers that show the same change, and are surrounded by muscle apparently normal; also the areas referred to above show projections into them of unchanged myocardial tissue. In general, these changes are suggestive of unequal fixation, but it is difficult to explain all these features on this basis. In addition, there is fragmentation of certain areas. (2) *Spleen.* Marked passive congestion. (3) *Liver.* Same as spleen. (4) *Kidney.* Marked engorgement of vessels of glomeruli and cortex in general. Very marked parenchymatous degeneration of proximal convoluted tubules, much less pronounced in the distal tubules. Marked œdema of medulla.

After a careful study of the record in this case, there is nothing shown as the cause of the myocarditis with its extreme, almost necrotic degeneration of the heart muscle. Repeated Wassermann's had been negative, but there is a loop-hole through which possibly we may find a reason why cardiolysis was not a more permanently successful procedure; this is, that the man suffered from periodical attacks of inflammation of the tonsils, and the record indicates that during and immediately following these attacks, the heart suffered in consequence. This was thought to be purely the constitutional expression of the tonsillar inflammation, and its

specific influence was not considered. Had the tonsils been removed, it is suggestive at least, in the light of the knowledge of today, that early tonsillectomy would have been a rational practice.

Within the past year I have had an opportunity of performing cardiolysis upon a second patient, although one of a somewhat different type, and of which I will briefly give the history, the temporary, rather brilliant result, the cause of the breakdown, and the postmortem findings.

A young lady, age 23, a resident of Denver, about four years ago began to suffer from shortness of breath; then her feet began to swell; later she developed pain over the precordia. There was a history of rheumatism and the usual diseases of childhood: measles, scarlet fever, etc. Her father died of heart disease; her mother from unknown cause; two brothers living — one has rheumatism and one has pleurisy. Physical examination, patient thin and anæmic; slightly cyanotic; pericardial friction sound over precordia; systolic murmur at apex; apex in anterior axillary line; veins in neck widely congested and cord-like. Negative venous pulse, however. Patient orthopnœic; right border of heart one-half inch to right of sternum. Liver enlarged to umbilicus; ascites present, and œdema of feet and legs. Lungs: rales over bases; no fluid. Urine, slightly albuminous due only to pus from a mild cystitis. Leucocytes 9,600. Weight 121 pounds 2 ounces.

Under the usual heart treatment the œdema disappeared and the pericardial rub subsided more or less; then a distinct precordial retraction was manifest; Broadbent's sign was present. Compensation was restored and the liver returned to its normal size. She was operated upon December 14, 1915. Large sections of the third, fourth, and fifth ribs were removed, from the sternum out. In doing this, two accidental incisions were made into the pleural cavity, but no collapse of the lung took place. When the ribs were cut away, the whole heart fell from the chest wall and found the place made for it. The operation was followed by an attack of suffocative pulmonary œdema, which threatened her life, but the œdema gradually disappeared. Following this, however, a rather general œdema took place which did not diminish under digitalis, notwithstanding which the heart seemed to be in pretty good shape. It was necessary repeatedly to aspirate the pleural and abdominal cavities. The patient remained in the hospital 133 days, and thereafter returned to be tapped, every two or three weeks, until August, the intervals gradually growing greater and greater. During this period she was sufficiently well physically to drive an automobile daily. Finally she felt so well that she wanted to go to her ranch in Colorado, and personally drove her car, a large one, from Omaha to Denver. Later she made a trip across the Rockies, at one time venturing to an elevation of 12,000 feet, and seemingly suffering no inconvenience. She returned to her ranch, where she indulged in very hard work. She was a very self-willed young lady and took advice pretty much as suited her temperament. On October 31 she returned to the hospital under the care of her physicians, Drs. Crummer and Anderson, her heart having, a few days before, broken down under the strain of too arduous exertion. Decompensation was present in a rather marked degree, and attempts at restoration of compensation were hindered because of nausea and vomiting due to passive congestion of the abdominal viscera. The abdomen was aspirated several times, and the patient was apparently improving, when, on November 15, after a slight exertion, she suddenly died. A rather interesting coincidence, this girl and my man patient both died in the Clarkson Hospital, on the same day. The postmortem revealed a heart so massive that it practically filled the entire left thorax. Dense bands of adhesion extended from the mediastinum to the right lung at the anterior edge; the entire precordium was attached to the ribs and under the sternum. It extended backward into the axilla. The left lung was forced backward in the pleural cavity until it occupied a space scarcely more than if completely collapsed, and was held by adhesions to the pleural diaphragm and pericardium. The parietal and visceral layers of the pericardium were adherent over the entire heart. The liver was enormously enlarged. The findings show that it would have been impossible in this instance, to free the heart by such a meager operation as had been done. It would have demanded radical anterior costal excision to the axillary line, and likewise of a part of the sternum. No microscopical examination was made.

As I stated formerly, and in the beginning of this paper, it is incomprehensible to me why Brauer's operation has received so little consideration in America; so far as I am informed, my cases are the only ones that have been done here. Altogether, in Germany, France, and England 38 patients have been operated upon. Perhaps this dearth of operation for the relief of a progressively bad pathology may be best explained in that physicians in general do not accurately differentiate the lesions of the heart and of its sac, and when cases of mediastinopericarditis *are* recognized, the hope of cure by surgical means has long-time passed. The fault is not with the operation.

A word again as to technique: practically nothing is found in the English literature

about this procedure. Only one of our text-books (Johnson's) gives it place. He says:

> The operation was devised for the purpose of removing the ribs which imprison the heart and interfere with the cardiac systole. The rigid, bony wall of the thorax is thus replaced by a soft elastic covering which is easily moved by the heart, and part of the cardiac power which previously had been wasted in overcoming the resistance of the thoracic wall, is conserved. The removal of the bony framework of the chest also permits the heart to drop back into the thorax, thus relaxing the lateral or posterior adhesions which may be present.

In order that this may be accomplished, it is essential that the ribs be removed in such a way that there can be no re-formation of bone, i.e., they must be removed with all of their periosteal covering. Although it is not easy to remove the posterior periosteal covering of the ribs, still it can be done and it is no material disadvantage if, in the doing, the pleura *is* opened once or several times. The lung does *not* collapse and the injury is easily repaired; besides, intratracheal insufflation anæsthesia can be employed if desired; this would eliminate any possibility of lung collapse. Johnson makes the statement that the periosteum which has been detached by the incision along the middle of the rib, is ablated after the removal of the ribs, in so far as this can be done without endangering the pleura. It is, in my opinion, a mistake to limit the removal of the periosteum to that which has been detached by the incisions along the middle of the ribs, this limitation being done to prevent the supposed dangerous consequences of pleural injury. Our knowledge of modern surgery of the chest does away with this bugaboo.

TUBERCULOSIS OF THE HIP-JOINT

By JAMES K. YOUNG, M.D., F.A.C.S., Philadelphia
Associate Professor of Orthopedic Surgery, University of Pennsylvania; Professor of Orthopedic Surgery, Philadelphia Polyclinic; Orthopedic Surgeon, Philadelphia General Hospital

IT was formerly the experience of orthopedic surgeons to treat many cases of tuberculosis of the hip-joint which were complicated with abscess and deformity, but by the modern methods, combinations of fixation and traction have eliminated these serious complications, thus greatly shortening the length of the disease.

During the writer's early experience in the field of orthopedic surgery, it was the custom to treat all cases of hip disease with a long Taylor traction splint, and this was the routine method of treatment that I became familiar with while under orthopedic training with Dr. A. Sydney Roberts. Subsequently, during my association with Dr. De Forest Willard, I gained a familiar experience with the Thomas fixation splint for ambulatory cases and the employment of simple traction for bed cases. For the last eight or ten years I have been using an original traction fixation splint.

The Taylor splint possessed certain advantages in that it made traction upon the joint, separating the joint surfaces thus relieving spasm, but it had these defects: the foot was not securely fixed and rotation of the hip-joint upon itself was possible. Another disadvantage connected with its use was its narrow pelvic band, allowing of too much flexion and extension. This was in a measure corrected by means of a strap passing across the top. Deformity not infrequently occurred requiring subsequent operation. The Thomas splint provided fixation and prevented flexion, so that deformity did not occur. The original combination splint overcame all these objections, the trunk was securely held by the body portion, flexion and lateral deformity were prevented, and traction applied to the limb relieved the joint pressure and muscle spasm.

Throughout all this treatment, an effort was made to hasten recovery and secure a movable joint without ankylosis. This plan is diametrically opposed to the treatment, as recommended by Lorenz, and referred to as "weight-bearing therapy," in tuberculous hip

diseases, which is based upon the assumption that it is impossible to secure in many cases a movable joint, and that the end-result should be an ankylosed joint in a good position for locomotion.

Just here it seems advisable to parenthetically state the method of Lorenz and the application of spica dressings in treatment of this class of cases. Much attention has been directed in the treatment of hip-joint disease, to the employment of long and short spica dressings, because of the eminence of its originator. Very shortly, however, it became only too apparent that much injury resulted from the unskillful use of the method, and that it was necessary to enlighten the practitioner in regard to it. The principle has been stated by Werndorff, as spokesman for this distinguished authority: "We came to the conclusion that the end-result of coxitis therapy should be an ankylosed and not a movable joint." After considering the question of traction or weight bearing, Lorenz decided that the only salvation of the hip-disease afflicted individual was to be sought in the ankylosis of the joint. With this end in view the limb was fixed in either a long or a short hip spica, with the part abducted, and the patient was then allowed to walk upon the diseased limb. These casts were applied under an anæsthetic. In the hands of a skilful surgeon of very large experience, as in the case of Lorenz, some cases recover, but in others abscesses form and deformity is engendered, and in every way this method of treatment becomes a decided regression. If the splint be applied to an acutely inflamed joint, it is almost certain to be followed by abscess formation and complete destruction of the joint. From personal experience, the writer can testify as to the probability of error, in the case of a patient under his care, who developed a large abscess with shortening and ankylosis after the application of a spica dressing by Professor Lorenz himself.

In all methods of treatment the object should be to obtain a good movable joint, without shortening and without deformity.

As a result of much experience, it has unquestionably been found that this, my original method here outlined, cannot be used to advantage in hospital work or outpatient ambulatory cases, as these classes of cases do not possess sufficient intelligence or persistence or attentiveness in their attendance to obtain the best possible results.

Modified forms of treatment have been employed with some measure of success; but throughout this article, it is to be understood that we are dealing with *private* orthopedic cases.

DIAGNOSIS

The diagnosis of tuberculous hip disease must be made positive (a), by clinical examinations; (b), by means of the roentgen rays; (c), by means of laboratory methods.

a. Clinical examinations. Of late years too little dependence has been placed on a correct interpretation of the disease as revealed symptomatically at the bedside, and emphasis should be placed on the earlier method of diagnosis, because within recent years too much attention has been given to the roentgen rays and to laboratory methods. The diagnosis should always be made first *clinically*, and these deductions should be unerringly confirmed by laboratory findings.

The two symptoms which are markedly characteristic of tuberculosis of the hip-joint are spasm and atrophy. These spasms are tetanic in nature and occur early in the course of the disease. The spasm is soon followed by atrophy, and these companion symptoms form a positive part of the symptom-complex in *all* tuberculous joint affections. In spine disease, especially in the lumbar region, spasm is often one of the earliest symptoms, antedating the occurrence of deformity. In hip disease the flexors and adductors are the first of the muscles to be affected; while at the knee-joint the hamstring tendons may frequently be found contracted very early in the affection.

b. Roentgen rays. The X-rays should not be taken to confirm the clinical examination, but they do show the location and extent of the disease in the joint. In addition to this the roentgen plate or photograph should be taken every three months, in order to study the progress of the disease and to determine the efficiency of treatment. It is difficult to make satisfactory photographs of cases of

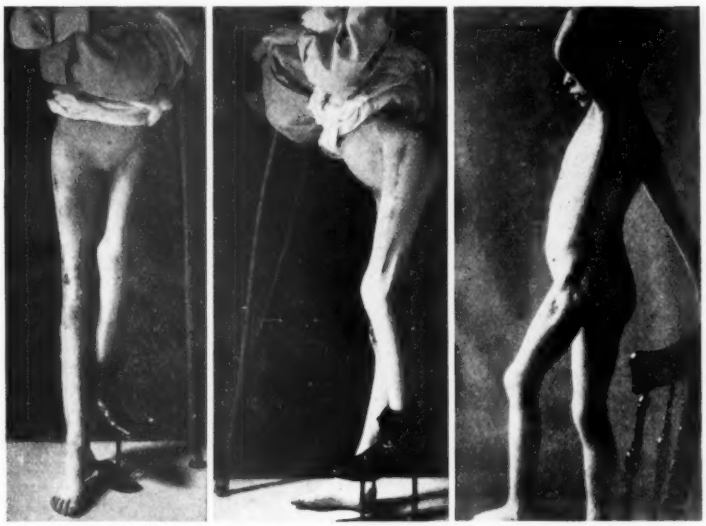


Fig. 1 (at left). Tuberculosis of both hips and one knee. (Treated by inefficient methods.)
Fig. 2. Same as Fig. 1, lateral view.
Fig. 3. Hip-joint showing excision of hip in a child. (Treated by inefficient methods.)

tuberculosis of the hip-joint, because the infiltration into the tissues and the exudation in and around the joint produce a hazy or cloudy effect, no matter how fine the technique or how excellent the quality of the material used. A cloudy picture is characteristic of tubercular hip disease, and it is only as the disease becomes arrested that the outline of the joint becomes more distinct. The first change observed in the texture of the bone is rarefaction; the picture showing a striated appearance of the cancellous structure, more clearly from absorption of the calcium salts at the seat of the disease. The most usual site for the primary focus is in the epiphysis or at the proximal side of the epiphyseal line, or at the epiphyseal line in the acetabulum. As the disease progresses, favorably, the areas of rarefaction become more uniform with the surrounding structures from re-deposits of lime salts. If the progress of the disease is not arrested, the areas of rarefaction increase, necrotic islands are cut off and atrophy of the epiphysis and extension upward of the acetabulum occur; and finally there is fibrous ankylosis of the opposing surfaces, with eventually the occurrence of true bony fibers connecting the remnants of the trochanter with the ilium.

c. By means of laboratory methods. In order to confirm the results of clinical findings, resort must be made to a differential blood count, to the Wassermann reaction and the complement-fixation test; tuberculin tests are also of value, as well as cultures of fluids about the joint, if they are procurable by means of a diagnostic puncture. In children von Pirquet's test should be employed; and while there may be an error of 15 per cent, its use should be tried. In adults resort is made to subcutaneous tuberculin tests. The examination should include cell counting; and if there is a great increase in the lymphocytes, more than 50 per cent, this should rather favor the existence of a tubercular joint affection; since the predominance of the polymorphonuclear variety is strongly indicative of an affection, non-tubercular in origin. The existence of the tubercle bacilli, staphylococci, streptococci, and actinomycosis, are readily revealed by microscopic examinations. If the smear slides are not

satisfactory and the culture findings are negative for tuberculosis, inoculation of guinea pigs, should be resorted to in suitable cases. In all doubtful cases this is my invariable practice. The reports, thus received, are as a rule, so tardy in their arrival, that they act as confirmatory measures, rather than as a positive aid in operative interference.

Some years since, I had examined by a bacteriologist the fluid taken from twenty-four operative cases under my care, several days before operation, all of these being joint cases, some of which required excision of the major joints. In this series of cases, six contained the tubercle bacilli; six contained pyogenic organisms and twelve were sterile. Among the organisms encountered were, streptococci, staphylococci, bacilli pyocaneus and pneumococci. Of the sterile abscesses, by means of inoculation into guinea pigs, two were negative and one was positive for tubercle bacilli. This critical investigation of the fluid is not important in determining the nature of the disease, but it is most valuable in the determination, as to what operative measures are to be instituted.

DIFFERENTIAL DIAGNOSIS

There are many diseases with which tuberculosis of the hip-joint may be readily confounded, and it is here that mention will be briefly made of several affections, from which it must be carefully differentiated. These include:

1. Non-tubercular synovitis
2. Non-tubercular chronic arthritis
3. Specific syphilitic arthritis
4 and 5. Injuries to the soft parts; fractures in and about the neighborhood of the joint
6. Coxa vara; coxa valga
7. Arthritis deformans
8. Osteomyelitis of the femur or ilium
9. Tuberculosis of the fifth lumbar vertebra
10. Sacro-iliac displacements
11. Sacro-iliac disease
12. Malignant disease of the hip-joint.

1. Non-tubercular synovitis. In this condition there is a marked effusion, and the capsule is thickened. The joint outline is enlarged and obliterated. Motion is quite normal and there is absence of reflex muscular spasm. There are also absent atrophy, pain and night cries. Whether the synovitis is septic or *not* its differentiation from tubercular hip-joint disease can be demonstrated by the use of tuberculin and by diagnostic puncture. The X-rays may be of some value, and within a recent period the separation of the joint surfaces by the collected fluid has been demonstrated. The exact character of the septic variety may be determined by a diagnostic puncture, or by making a culture of the fluid after operation.

2. Non-tubercular chronic arthritis. In this affection there is no flucation and the capsule is not thickened. The joint outline is distinct and motion is limited. There are present, reflex muscular spasm, marked atrophy and pain upon motion. Night cries are also present.

3. Specific syphilitic arthritis. In this condition there is slight effusion and there is some thickening of the capsule. The joint outline, enlarged and indurated, appears with much distinctness. Motion is limited. Reflex muscular spasm is absent; the degree of atrophy is slight, pain is moderate upon motion. There are no night cries.

4 and *5. Injuries to the soft parts; fractures in and about the neighborhood of the joint.* There should be no confusion between these and a well-marked case of hip disease; if the classical symptoms of hip-joint disease are carefully considered and especially if the X-rays be the means of corroboration. In old fractures about the neck of the femur, the marked limitation of abduction is often most deceptive and has not infrequently led to errors in diagnosis. Yet the roentgen-rays will at once clarify the diagnosis.

6. Coxa vara; coxa valga. The foregoing remarks apply equally well to coxa vara, and to a lesser degree to coxa valga.

7. Arthritis deformans. This can be readily dismissed. Children are seldom afflicted with arthritis deformans, but when it does occur, lesions in other joints make it quite characteristic. Sight should not be lost of the so-called Still's disease, where the characteristic symptoms include: arthritis, profuse sweats,

Fig. 4.

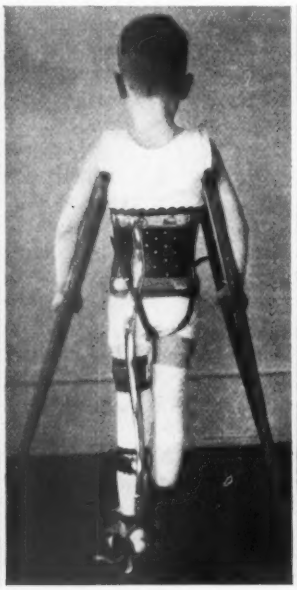


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 4. Anterior view of the author's original hip splint.

Fig. 5. Posterior view of the author's original hip splint.

Fig. 6. Author's convalescing hip splint. Anterior view showing knee and hip locks.

Fig. 7. Posterior view of author's convalescing hip splint.

splenic and glandular enlargements, slight elevation of temperature, etc. It is in just such cases as these, that a thorough clinical examination is of prime importance to eliminate the presence of a tuberculous arthritis.

8. Osteomyelitis of the femur or ilium. Chronic osteomyelitis of the femur is frequently treated over long periods under the mistaken diagnosis, of tubercular hip-joint disease. The history of the onset, the lesions in other joints, the X-ray diagnosis and laboratory methods should clarify any error in diagnosis. The roentgen photograph, in place of exhibiting a destructive process with areas of necrosis and fibrosis offers a hypertrophic condition with the presence of sequestra. When, however, chronic osteomyelitis is engrafted as a mixed infection upon a tubercular process, the diagnosis, hangs very largely upon the X-ray plate.

9. Tuberculosis of the fifth lumbar vertebra. The contraction of the psoas muscles and the pains referred to the region of the hip, might distract attention from lumbar tuberculosis or malignant disease. The first noticeable symptoms may be the occurrence of a limp and limitation of movement in one limb, or the presence of pus in the psoas muscle. This latter phenomenon is usually confined to forced extension; limitation of motion at the hip-joint makes the diagnosis still more masked. In either event, however, muscular spinal rigidity from reflex spasm will establish the true nature of the affection, still further corroborated by the existence of a kyphosis.

10. Sacro-iliac displacements. There is little similarity between this condition and tuberculous hip-joint disease. The elongation of the limb is produced by downward displacement of the ilium and there is lameness and pain; but the seat of tenderness is entirely different from that in hip-joint disease. In sacro-iliac displacement there is no abduction of the limb, there is no shortening

and no pain, on moving the hip, if the pelvis be fixed.

11. Sacro-iliac disease. The acute character of the gonorrhœal infection of the joint with typhoid and local inflammatory symptoms, should lead to an early diagnosis. When streptococci and staphylococci are found, the symptoms are not so severe, and more time is afforded for the careful diagnosis.

12. Malignant disease of the hip-joint. This affection is rare but great pain, rapid swelling, and marked induration, should guard the practitioner. All tests for tuberculosis should be invoked in an effort to arrive at a diagnosis by exclusion. Subsequently the microscope will determine the true character of the process, whether sarcoma or carcinoma.

TREATMENT

The author's method of treatment is divided into two parts: first, the use of a fixation traction splint during the acute stage; second, the use of a convalescing hip-splint.

Author's splint. This splint (Figs. 4 and 5) is made from a plaster-of-Paris cast and extends from a point midway between the costal border and the axilla to the toes on the affected side, including the trunk and leg. The thigh is slightly abducted and the knee slightly flexed. From this a leather body-portion and a leather thigh and calf portion are made, the splint being reinforced by a posterior steel or other metal bar, the bar terminating in a plate, which secures the foot in dorsal flexion. Perineal straps form part of the splint, and by means of an anklet and straps, traction is made upon the limb, relieving the joint spasm. The patient wears a wooden and cork "patton" on the *sound* foot and walks upon crutches. Great care is used to extend the limb from time to time, so that a uniform traction is maintained, and provision is made in the splint for the growth of the individual. The splint is worn from twelve to eighteen months. It is removed once a week and the limb is carefully examined every month, and gently moved by the surgeon only at this time.

The progress of the disease is carefully observed through the clinical symptoms and a study of the roentgen-rays.

The convalescent splint. When all the symptoms have disappeared and the rays reveal the presence of lime salts and healing has occurred, the author's convalescent splint (Figs. 6 and 7) is applied. This consists of a pelvic band, with a lateral steel bar, extending from the pelvic band to the foot-plate and is worn inside the shoe and joined with locks at the knee and at hip and secured in place by broad leather calf and thigh bands. Perineal straps are used. The patient wears ordinary shoes and goes about without crutches, the weight being borne on the perineal straps. The splint is locked while walking, and it is never unlocked until from three to six months have elapsed. Then the patient unlocks it when sitting down.

RESULTS OF TREATMENT

While formerly there were 50 per cent of abscesses in all cases of hip-joint disease by all forms of treatment, and whereas deformity was commonly observed, the present method in private practice, has resulted in one case of abscess out of a large number of cases in my own experience during the last eight years and the occurrence of deformity and ankylosis have only been a rare exception. There have been no deaths. Formerly the percentage of deaths were 34 in 1000 or approximately, three-tenths of one per cent.

HYDATID CYST OF THE LIVER WITH REPORT OF TWO CASES[1]

By GEORGE BEN JOHNSTON, M.D., and MURAT WILLIS, M.D., Richmond, Virginia

WE have had two cases of hydatid cyst of the liver during the past two years, and about six months ago another case was operated on in a Richmond hospital. This is remarkable, because of the fact that prior to 1913 only two cases of tænia echinococcus infection were reported from Virginia, and two hundred and fifty from United States and Canada. The Virginia cases occurred in Alexandria and Staunton. There was, however, another case that was infected in Virginia, but was reported from Buffalo by Cary and Lyons.

During the winter of 1913–1914 several epidemics of tænia echinococcus appeared in Virginia raised hogs. In one consignment from Charles City County, slaughtered in Richmond under the supervision of the Bureau of Animal Industries, there were forty-six animals, and all forty-six were infected with the tænia echinococcus. In another shipment from Goochland County there were eight hogs, five of which were infected. In a number of small consignments during the winter of 1913–1914 there were one or more animals infected with this parasite. In November of this year in a shipment of sixty hogs from Charlotte County fifteen were infected with hydatids (25 per cent).

Dr. Hall states in *Bulletin 206, U. S. Department of Agriculture*, that "recent abattoir figures show an alarming prevalence of disease in domestic animals in some parts of this country, notably in certain localities in Virginia, Arkansas, and Oklahoma; and the prevalence of hydatids in domestic animals is an index of the danger to which people are exposed. The bare fact that hydatids occur at all in the United States is of itself a cogent argument for the suppression of the dog nuisance as a measure necessary for the public welfare."

It may be a mere coincidence, but to us it is more than one that the sudden increase of tænia echinococcus in human beings should parallel an increase of the condition in hogs. Can there be a relation between the two? If not, are the dogs in Virginia more heavily infected than formerly? These questions are extremely interesting, but difficult of investigation.

Dr. Marshall tells us that it has been his observation that hogs raised in a small pen are more frequently infected with hydatid disease than hogs raised with ample pasturage. The hogs that are particularly prone to this infection are those which are fed from the table and kitchen refuse. He explains this by the fact that the smell of food attracts the dog, in consequence of which, the farmer feeding his hogs is invariably accompanied to the pen by a dog. In this way the hogs come in close contact with dogs or with the egesta from dogs, and the dangers of infection are thereby accentuated.

If there is any relation between hydatids in men and hydatids in hogs, we would naturally look for it in rural districts, because in these districts the slaughter of animals is not supervised by the Bureau of Animal Industries, and there the hogs are more frequently infected and the offal is not as carefully dealt with as in the abattoirs where inspection is rigid.

Man may be directly infected from careless use of infected organs, but we are inclined to think that most of our echinococcus infections are traceable to the water supply, to raw vegetables contaminated by egesta from dogs, and to dogs themselves. The disease, however, is conveyed to the dog by the eating of infected organs, and in this respect the hog is active in keeping alive this condition in certain localities in Virginia.

Our two cases came from the rural districts, and they were frequently exposed to infection both from dogs and from meat that was not properly inspected. The case that was operated on in Richmond several months ago occurred in a foreigner who had lived in this country a short while. Our cases, however, were not from the region in which the epidemics in hogs were reported.

[1] Read before the Southern Surgical and Gynecological Association, November, 1915.

Geographically, tænia echinococcus is a widespread disease, and in certain countries it occurs with great frequency; especially is this true in Iceland and Australia. In the former country, according to the statistics of Galliot, about one out of thirty of the entire population is infected. In Australia the returns extending over many years of the Mount Gambier Hospital show one hydatid patient for every sixty-five admitted for all complaints. In both Iceland and Australia sheep raising is done on a large scale, and a survey of the geographical distribution of the hydatid disease leads to the conclusion that sheep, and especially fine-wooled sheep, such as the Merino breed, are responsible to a large extent for the infections in dogs. In Australia and Iceland 40 per cent of the unregistered dogs were found to be infected.

We believe that the hog is playing the same rôle in Virginia that the sheep is playing in Australia and Iceland, and that if a search were made we would find that tænia echinococcus is more frequent in Virginia dogs than we suppose, and further that the tænia echinococcus infections are increasing among them. According to Hall, the prevalence of hydatids in dogs is an index of the danger to which people are exposed. If this be true, we naturally look for more infections with tænia echinococcus in man throughout Virginia.

Echinococcus in man shows two forms: the echinococcus hydatidosus and the echinococcus alveolaris. Both of our infections were of the hydatic type. The alveolar type is seldom seen in this country, but is fairly common in some parts of Austria and Germany. The alveolar type is usually a fatal infection.

The distribution of hydatids in the body, according to the table compiled by Thomas, shows the different organs are attacked in the following percentages: liver, 57; lungs, 11.6; kidneys, 4.7; brain, 4.4; spleen, 2.1; heart, 1.8; peritoneum, 1.4.

The echinococcus cyst originates primarily from a little tape-worm found in dogs. This tape-worm sheds off its terminal proglottis which is filled with a large number of eggs. This passes out of the intestinal tract with the egesta and sooner or later the eggs are liberated from the proglottis, and they may float about on particles of dust, or they may be carried to a neighboring water supply. Human beings and domestic animals drinking this water or inhaling dust are subjected not to a tape-worm infection but to an infection characterized by the presence of hydatids or bladder-like bodies in the different organs.

The eggs which are taken into the gastro-intestinal tract in human beings probably get into the liver through the lymphatics, and there (liver) in the interlobular tissue they produce these cyst-like bodies which show two separate and distinct capsules: an inner or brood capsule which as the name implies tends to reproduce the parasite, and an outer or fibro-elastic tissue capsule, which is supplied by the organ in which the cyst is located. The hydatid grows at the expense of an organ, and strange as it may seem the organ seems to take kindly to the growing cyst. Such cells as are destroyed by the cyst are replaced elsewhere in the organ by a compensatory hypertrophy and unless the cysts are quite numerous and growth quite rapid there is little loss of function of the organ. The fibrous tissue capsule surrounding these cysts is seldom thick, and is usually vascular so as to be able to furnish the cysts with nutrition.

The symptomatology of hydatids depends almost entirely upon the pressure effects exerted upon the organ. In the liver there may be an aching about the right shoulder, a sense of weight and distention. Actual pain is rare, but if suppuration intervenes, as sometimes occurs in the liver, excruciating pains in the liver region may exist. On the other hand, not infrequently an autopsy may reveal a cyst of considerable size which gave no symptoms. The liver may enlarge and may extend below the costal arch and higher up into the thoracic cavity; especially is this true in large, deep-seated cysts. The rupture of a hydatid cyst of the liver is dangerous. The contents of the cyst may be squirted into the pleural cavity or peritoneal cavity, depending, of course, upon the location of cyst.

Treatment. So far as we know surgery is the only method of treating this condition. Wherever possible it is always best to remove the cyst *in toto*, if this be impossible to remove as much of the cyst as possible and drain, and

Fig. 1 (at left). Echinococcus cyst of the liver (human).

Fig. 2. Echinococcus cyst of the liver (pig).

if this be impossible to aspirate the cyst. The whole question of treatment is well summed up in Albutt's *System of Medicine*, in an article by Sterling and Verco.

1. The objections to aspiratory puncture are that it is only applicable to a small class of cases; that even in these it frequently fails in its object; that it is in itself a possible source of danger, by inducing suppurative changes, or by permitting leakage of fluid with possible consequences that we have sufficiently indicated; and that, at least, it leaves the dead organism in place. In pulmonary hydatids there is a special risk of suffocative flooding.

2. Removal of the parasite by incision is an effectual and, with proper care, a reasonably safe proceeding; it should be the general practice.

3. Lindemann's operation, in which, after removal of the parasite, the activity of the adventitious sac is left to drain externally, has stood the test of a large experience with favorable results, and is probably the best and safest procedure for general application. Possibly, however, Bond's operation, or some modification of it, in which, after evacuation, the emptied adventitious sac is left behind, may prove to be more satisfactory in certain cases.

CASES

CASE 1. Married woman, age 48, entered Abingdon Hospital April 10, 1915, complaining of a mass located in upper portion of right abdomen. Family history, unimportant. Past history, unimportant.

Present illness began about two years ago with dull pain in upper right abdomen. Some time after the pain began, she noticed a small lump in the region in which the pain was located. This lump has grown steadily. At no time was the pain severe. She has never been jaundiced, and seldom nauseated. She has lost considerable weight during the past two years, and during the last three or four months she has been unable to attend to her household work. Examination was entirely negative, except for a mass about the size of a cocoanut lying in the right upper quadrant; this mass was tender, was movable with respiration, was smooth or symmetrical, and apparently was separate from the liver.

Urine negative. Blood examination negative.

Operation April 10, 1915. The abdomen was opened by a high right rectus incision. On entering the abdominal cavity a large cyst attached to the under surface of the liver was seen, and several smaller cysts were found to be imbedded in the liver substance. The largest cyst (about the size of an orange) was enucleated without rupture. The liver was sutured with catgut to control the bleeding, the other cysts were left. Wound closed without drainage. Patient's postoperative course was uneventful and she was discharged from the hospital on the sixteenth day, and has been well since.

Hooklets were found in the cyst fluid.

CASE 2. Married woman, age 62, entered Johnston-Willis Sanatorium April 20, 1914, complaining of epigastric pain. Past history, unimportant.

Present illness began two years ago with a pain in right shoulder and a slight epigastric discomfort There was some nausea and occasional vomiting attacks after meals. At no time was the pain severe. She has lost some weight. She has never been jaundiced, and her bowels have moved with regularity. Physical examination, entirely negative, except for a slight tenderness and a mass about the size of the fist in the epigastrium. Urine, blood, and stomach examinations negative.

Under ether anæsthesia April 22, 1914, the abdomen was entered through a high right rectus incision. The liver was examined and found to contain a large number of cysts, ranging in size from an orange to a walnut, and seemingly deep down in the liver substance. The aspirated fluid was clear and colorless. No scolices were found in the aspirated fluid. None of the cysts were removed and the wound was closed and drain was put at the site of the aspirated cyst. The patient's convalescence was satisfactory; discharged from the hospital, May 14, 1914.

DEPARTMENT OF TECHNIQUE

THE KONDOLÉON OPERATION

Report of a Case

From the Service of William B. Brinsmade, M.D., Long Island College Hospital

By ROBERT S. BARBER, M.D., Brooklyn

LYMPHATIC obstruction from any cause produces dilatation of the lymph-vessels, lymphangiectasis, and results in osmosis into the surrounding tissues. The resulting lymphœdema may cause great increase in size in the parts affected. In some cases the skin is unable to maintain its nutritional balance and areas of discharging ulcers or sinuses are formed. Depending upon the amount of discharge, this last condition is known as lymphorrhœa or lymphorrhagia. The composite picture occurs most frequently in the lower extremity, and is known as elephantiasis.

In Kondoléon's seven reported cases, four followed acute or chronic infections; the fifth resulted from total removal of the inguinal lymph-nodes; the sixth was idiopathic; the seventh, an arm case, was a sequel of carcinoma of the breast, previously operated upon with a recurrence in the axilla. Handley's cases were both secondary to carcinomata of the breast which had been operated upon. The case reported by Lanz was idiopathic. Other accepted causes of the condition are: filariasis, tumors, scars or ligation of lymphatics. In cases due to malignancy Handley has shown that strands of carcinoma-cells first infiltrate the connective tissue, and then permeate the lymph-spaces, which rupture, producing an inflammatory reaction and fibrosis. It is the last process which produces the lymph stasis. The œdema is not due to compression of the vein, because ligation of the vein in emergencies does not produce œdema. Arterial ligation as a curative operation is futile because it does not correct the pathological process.

The superficial lymphatics lie above the deep fascia and anastomose freely with each other. The deep lymphatics lie below the deep fascia, and these too have a free anastomosis. The superficial and the deep lymphatics anastomose with one another only through the lymph-nodes. Thus the deep fascia offers an absolute barrier between the superficial and the deep lymphatics. Upon this fact is based the principle of the surgical treatment of block.

Lanz, a Hollander, in 1911, published a new operation which he applied to a case of elephantiasis of the lower extremity. Through a long incision in the outer aspect of the thigh, he split the fascia lata, and trephined the femur in several places. He then inserted strips from the fascia into the openings in the bone. Fascia closed in part and wound closed without drainage. His case, which was of four years standing, made a complete recovery.

Handley, an Englishman, in 1908 reported two cases of lymphatic block of the upper extremity, which he treated successfully by insertion of strands of silk in the subcutaneous tissues from the wrist to the uninvolved skin of the axilla. He obtained good results as far as the œdema was concerned.

Kondoléon, a Greek surgeon, giving due credit to these pioneers for the underlying principles of treatment which they had pointed out, in 1912 published an operation which he had done successfully in seven cases. The operation has since borne his name. By his studies and experiments he showed that the lymphœdema was limited by the deep fascia below and the skin above. He made two incisions (or four if the thigh were also involved) on the inner and outer side of the extremity, several inches long, down to the deep fascia. Redundant œdematous fat and superficial fascia he excised in part. A strip of the deep fascia three to four fingers in width was then removed from the underlying muscles. All hæmorrhage was thoroughly stopped by ligatures and the skin closed without drainage. The results of the operation were uniformly good. In his first case he had to repeat the operation twice, because his fascial excisions were not sufficiently extensive. In one of his earlier operations

he twisted the elevated band of deep fascia into a cord and tucked it into the deep muscles, leaving the upper end of the fascial strip attached.

Dean Lewis of Chicago has done the operation once in an unreported case. He obtained a perfectly satisfactory result.

AUTHOR'S CASE

D. G., male, 34 years old, a laborer. Past history negative. Present history: On July 2, 1914 he received a punctured wound of the left index finger. On the following day the finger was painful and swollen, with swelling beginning to extend up the forearm. There was crepitation in the hand and wrist due to some gas-forming organism. On July 9, 1914, multiple incisions were made in the hand and wrist. The wounds healed and the patient returned to work in the capacity of a watchman for one year. On June 8, 1915, the man was returned to his original task of hard manual labor with pick and shovel. On June 10 the left hand and forearm were greatly swollen although there were no signs of infection and very little pain. The left forearm was brawny and hard and 1½ times the size of the right.

Operation, August 7, 1915. Inicison 5 inches long along inner aspect of left forearm. Fascia exposed and 5 inches of fascia two fingers in width removed; wound closed without drainage. The result of the operation was improvement but not complete relief. Use of the arm caused the swelling to return. He returned to hospital on October 1, 1915 and was operated upon again. An operation similar to the first was done on the outer aspect of the forearm. Primary union resulted. Three weeks after this operation the forearm was the same as the right in size and consistency. Reports from the patient's physician six months after the operation show a satisfactory result with no return of the œdema. The forearms are of equal size. There is no disability.

CONCLUSION

Experimental work by Opie has shown that the coagulation time of lymph is from ten to twenty minutes: of blood, four to six minutes. This fact alone probably accounts for the relative infrequency of lymphatic thrombosis as compared with hæmic thrombosis. Transient œdema disappears in two to four days either by new channels or by collateral lymphatics. Lymphœdema lasting for several weeks after the disappearance of the inflammatory process which produced it, is due to lymphatic block and is probably permanent. The Kondoléon operation offers a means of relief, which is not obtainable by any other method.

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THE DIAGNOSIS AND TREATMENT OF TUMORS OF THE URINARY BLADDER[1]

BY FRANCIS M. McCALLUM, M.D., F.A.C.S., KANSAS CITY
Attending Genito-Urinary Surgeon, Christian Church Hospital, the Swedish Hospital, the Kansas City General Hospital
AND
CLINTON K. SMITH, M.D.
Alternate Attending Genito-Urinary Surgeon, Kansas City General Hospital

IT is not our purpose at this time to discuss the etiology and pathology of vesical neoplasms, but to set forth in as concise and comprehensive a manner as possible, the essentials of the symptoms, diagnosis, and treatment of these growths.

SYMPTOMS

The cardinal symptom is hæmaturia, intermittent or constant. According to Keys, "the first, last, and often the only symptom of tumor of the bladder is hæmorrhage. The characteristic hæmorrhage of a neoplasm, whether renal or vesical, begins without warning, continues copious and painless, unaffected by rest, diet, or medication, and ceases as it began, without apparent reason. Its cessation may leave the urine normal and the patient lulled into a false sense of security, by what he considers his escape from a serious condition. Pain and dysuria usually appear some days, weeks, or months after the first hæmorrhage. Exceptionally pain and dysuria precede the hæmorrhage. This is alleged to occur most frequently in sarcoma. Sharp lancinating pains also arise spontaneously from malignant growths."

At times, the symptoms may suggest vesical calculus, especially in children, with pain referred to the glans penis.

McCarthy[2] describes the symptomatology as follows: "An idopathic, intermittent hæmaturia,

[2] McCarthy. Tr. Am. Urol. Ass., 1912.

[1] Read before the Jackson County Medical Society, November 21, 1916

usually total; rarely, when the growth is located in the region of the vesical neck, the blood will be more pronounced at the end of urination. This hæmaturia is capricious, entirely independent of external causes. In fact, it is frequently more marked when the patient is resting quietly in bed, disappearing and reappearing without discernible cause. Thompson has called attention to dysuria as indicative of malignancy. Hæmaturia in the presence of a sessile or an infiltrating growth, associated with bullous œdema, is absolutely pathognomonic of malignancy."

In view of these facts, the presence of blood in the urine should be considered an alarming symptom, and when one realizes that every case of vesical tumor is potential of malignancy, it would seem that, as suggested by Kelley, "in the best interests of the patient, every case of undetermined hæmaturia, should be referred to the specialist for early diagnosis and treatment."

DIAGNOSIS

Usually, the best method of determining the presence and characteristics of a bladder tumor, is with the cystoscope. In fact, it is in the diagnosis of vesical tumor that cystoscopy has attained its greatest triumph. With the cystoscope, one usually can readily determine the location, size, shape; whether or not the tumor is villous or nodular, pedunculated or sessile, diffuse or circumscribed.

In using the cystoscope in an attempt to discover the existence of a vesical tumor, one should observe the bladder while fully distended, and also during the process of filling and emptying, as in this way small buds may be discovered which might be otherwise overlooked. This is especially true in cases of recurrence.

As it is impossible within the limits of this paper to discuss the differential diagnosis of vesical tumors, from a pathological and histological standpoint, it would seem expedient to refer those interested to the excellent symposium on this subject, by Buerger.[1]

From a clinical and therapeutic standpoint, tumors of the bladder may be classified as benign and malignant. Representative of these two groups, are, respectively, the papillomata and the carcinomata.

Papilloma. As ordinarily used, this term designates a benign tumor; either single or multiple, sessile or pedunculated, having a surface made up of branching arms, terminating in fingerlike projections, or villi, composed of a central connective-tissue stem or axis, accompanied by a loop of blood-vessels, and covered externally by one or more layers of epithelium.

Carcinoma. These are usually broad based, hard, sessile tumors, likely to be not freely movable; but in individual cases may resemble a benign papilloma. In many cases, the macroscopical appearance of these two forms of vesical tumor may be so closely allied that the tumor tissue must be submitted to the pathologist and the microscope before a differential diagnosis can be made with certainty. For this reason, only early and accurate diagnosis and radical treatment can best subserve the interests of the patient.

In a bladder more or less choked with a papillomatous tumor, much useful information can be gained by the use of the X-ray. This is accomplished by injecting the bladder with a sufficient amount of thorium to distend the bladder, but not to overshadow the growth. An X-ray picture of this kind shows the available space not occupied by the tumor, and in some cases, which, with the cystoscope, appear to be inoperable, it can be seen that the tumor is a large villous mass, with a small pedicle, and can be readily removed by surgical interference.

TREATMENT

The treatment of every case of vesical tumor, is by eradication at the earliest possible moment. The simplest benign papillomata, tend to transformation into malignancy.

According to Schmidt,[2] "if the growth is permitted to continue, hæmorrhage and sepsis, and the results of backward pressure and infection, that is pyelonephritis, occur. To permit such to occur at the present time, should be nothing less than a crime."

In order to properly select an appropriate and efficient mode of attack, in a given case of vesical tumor, one must necessarily have decided that a tumor is to be dealt with; the number, situation, type of implantation, and the degree of development of the neoplasm, at the time treatment is instituted. The treatment of every case of vesical tumor, except in a certain percentage of late carcinomata, is essentially surgical.

At this time, we shall consider only two principal modes of attack; namely, transurethral electrothermic coagulation, and transvesical section. In certain selected cases a combination of both may be advisable. Both of these methods should be augmented, in all cases of suspected or known malignancy, by massive roentgen therapy, or radium, or both.

[1] Tr. Am. Urol. Ass., 1915.

[2] Tr. Am. Urol. Ass., 1915.

Transurethral electrothermic coagulation, or desiccation, of vesical tumors, consists of the application of the high-frequency current, to the tumor by means of an insulated wire, introduced through the cystoscope. The method was introduced by Edwin Beer.[1] He employed the monopolar or Oudin current, in essentially the same manner as used at present. The same year the bipolar or d'Arsonval current, was used by Keys,[2] but subsequently abandoned in favor of the Oudin current.

While both methods are employed at the present time, the Oudin current seems to be the one of choice, by most operators. The effect of the monopolar current, is a relatively superficial coagulation, while that of the bipolar, is a deep baking process, capable if used in sufficient strength, to cause the destruction, to almost any extent, of the tissue involved. While it is conceded to have its advantages, in certain selected conditions, it can be readily understood to be a dangerous procedure, in the hands of any except the most experienced surgeon; especially so if applied in proximity to the peritoneum. Some operators hope by the use of this current, to destroy the carcinomatous base of a papillomatous tumor, and that this can be accomplished, is illustrated by the following case.

CASE 1. Miss H., age 53. Present trouble began in January, 1916. At this time patient noticed blood with the urine. This rapidly became more pronounced, and was soon accompanied by considerable pain, especially at the end of urination. On June 18th, patient appeared at office for examination. Cystoscopic examination revealed a rather large villous tumor, situated just above the left ureter. Tissue removed showed the growth to be a papillomatous carcinoma. At this time patient was passing a large amount of blood, accompanied by much pain on urination. The Oudin current was applied at intervals of three to eight days. The tumor rapidly decreased in size, although some rather alarming hæmorrhages occurred between sittings. The treatments continued over a period of ten weeks. As soon as the base of the tumor was reached, the d'Arsonval current was applied. This was used twice, followed by one sitting with the Oudin current. On September 28th, cystoscopic examination showed the tumor entirely disappeared, the area of the base occupied by contracted scar rissue.

As to what cases are suitable for high-frequency treatment, is a topic for much discussion and wide variance of opinion. That it is the method of choice in all cases of benign papilloma, of moderate involvement, is pretty generally accepted. That it is contra-indicated in most cases of clinical malignancy, is equally well known. Opinion as to what degree of malignancy constitutes a contra-indication varies with the individual operator. However, in the presence of hard, sessile tumors, intractible cystitis, sloughing or ulcerated tumors, great multiplicity, or tumors of great size, the high-frequency method alone, may be well said to be contra-indicated.

The principal factor, in favor of the use of the high frequency current, is the minimum discomfort and inconvenience to the patient. By this method, a radical course of treatment can be applied in the office. The patient readily accepts the treatment, as he is able to pursue his regular duties, without inconvenience or loss of time.

Another factor in favor of the use of the high-frequency method of treatment, is the ease with which recurrences can be handled. In every case of vesical tumor, the patient should appear for frequent postoperative cystoscopic examination. And when recurrences in the form of small buds are discovered, they can be at once attacked and subdued by this mode of treatment.

The high-frequency current is also a potent factor in the control of hæmorrhage in vesical tumor. Alarming hæmorrhage may occur at any time. This sometimes follows treatment, when the burned area separates from the tumor. In cases of this sort, the proper procedure is, more of the same treatment in the same place. In this connection it is well to state that in cases where the patient becomes anæmic from loss of blood, an excellent procedure is to perform a transfusion.

Technique of the application of the high-frequency current. As previously stated, transurethral electrothermic coagulation is applied through the cystoscope. The cystoscopic technique, in the application of the high-frequency current, is essentially the same as used in ureteral catheterization. As recommended by Thomas,[3] a double catheterizing cystoscope should be used, and an insulated wire cable introduced through each catheter channel. In this way, when a wire becomes blunted or welded, as frequently happens, before a treatment is completed, it can be abandoned and the sitting completed without withdrawing the cystoscope.

As to the manner of applying the electrode to the growth, some difference of opinion exists. While some operators recommend the application of the electrode directly to the pedicle of the tumor, it should be considered a more or less dangerous procedure, as a routine measure. Its only advantage would seem to be a shortening of the course of treatment, and in most cases, where it is possible to make use of the high-frequency method, haste is not a compelling factor.

[1] Tr. Am. M. Ass., 1910.
[2] Am. J. Surg., 1910, July.
[3] Tr. Am. Urol. Ass., 1915.

As a general routine, the safest and most efficient plan is, to apply the electrode to the periphery of the tumor, and advance toward the base, at each sitting, as rapidly as the separation of the previously coagulated tissue will permit. In approaching the base of the tumor, one should use care and not burn too much tissue at one sitting, as deep desiccation of the bladder wall, may be followed by perforation.

The frequency of the sittings, must be governed by the tolerance of the individual patient and the character of the tumor. If the patient be tolerant, or the tumor of the large villous type, frequent sittings may be practiced. With a large villous tumor a good plan is to burn a different area at each sitting with short intervals between each treatment. As a usual thing in all cases, the treatment should be pushed as rapidly as the burned tissue separates. This usually occurs in about three to eight days, and this should be about the time between treatments.

In regard to the care of the patient between sittings, the sloughing tissue must be considered a foreign body and an excellent culture medium for bacteria. For this reason, frequent lavage of the bladder, with antiseptic solutions, is to be recommended.

During the course of treatment, the patient should be constantly within reach of the surgeon, as alarming hæmorrhage may appear, as before stated, and requires prompt attention.

As to the time required for the removal of a vesical tumor, by the application of the high-frequency current, no definite estimate can be given. Suffice to say, however, that most papilloma, especially of the benign type, are readily removed within a few weeks, by this method of treatment.

Should the growth not materially decrease in size after a reasonable number of treatments, it should be considered clinically malignant and beyond benefit by this method, and it should be immediately attacked by transvesical section.

That the high-frequency current is a most practical and successful method of treating a variety of vesical tumors, is evidenced by a report of the following cases:

CASE 2. Mr. S., age 50. Family history unimportant. Previous history negative. Present trouble began in July, 1912, when he began to have intermittent attacks of severe hæmaturia. His condition became progressively worse and on December 15, 1912, this patient was passing enormous quantities of blood and had lost control of the vesical sphincter. The patient was very weak and anæmic and had a hæmoglobin of 54. Cystoscopic examination showed the bladder filled with multiple villous tumors, which proved to be papillomatous carcinomata. On January 16, 1913, the growths were removed by suprapubic transvesical section. The patient's symptoms rapidly cleared and he made an uneventful recovery. One year later tumors again appeared, and were again removed in the same manner, except that the bases of the growths were fulgurated. He was referred to Dr. Skinner who gave him deep X-ray therapy. Recent cystoscopic examination and X-ray picture taken with thorium in the bladder shows normal capacity and no recurrences.

CASE 3. Mr. H., age 59. Denies venereal infection. Present trouble began in July, 1913. Patient first experienced distress in the suprapubic region, accompanied by frequent and painful urination. He soon began to pass small calculi with considerable terminal hæmaturia. On September 5, 1913, cystoscopic examination showed a fairly large, hard, sessile, nodulated tumor, situated near the base of the trigone, and covered with incrustation. Tumor rapidly decreased in size under high-frequency treatment and entirely disappeared within twelve weeks. No recurrence.

CASE 4. Mrs. B., age 48, married. Present trouble began in December, 1915. At this time the patient first noticed blood in the urine. This was soon followed by rather constant passage of blood from the urethra, during the intervals between urination. Suprapubic distress was constant, and pain on urination was very severe. Her condition rapidly grew worse, and January 1, 1916, some sort of growth was removed from the upper urethra. The patient improved somewhat, but the pain and hæmorrhage continued. On March 5, 1916, she applied at this office for treatment. Cystoscopic examination showed a riot of small papillomatous growths surrounding the vesical sphincter and in the upper urethra. Under ether anæsthesia, deep fulguration was applied to the growths. The patient improved somewhat but the pain and hæmorrhage did not entirely disappear. On May 15, 1916, she again entered the hospital and deep fulguration was applied to the remaining parts of the growths. The patient's condition rapidly cleared up. Frequent cystoscopic examinations show no recurrence.

CASE 5. Mr. O., age 37. Family and previous history negative. Present trouble began in March, 1915. First noticed what he thought was small amount of blood passing with the urine. This rapidly increased in volume accompanied by marked terminal hæmaturia. He also began to pass some clotted blood as his condition became more aggravated. Patient had no pain at any time. On June 15, 1915, cystoscopic examination showed a medium sized villous tumor just below the left ureter. Under fulguration treatment, the patient's symptoms rapidly disappeared and he was discharged on August 15th, with no evidences of the growth. Small recurrence appeared one year later. After two treatments bud disappeared.

CASE 6. Mrs. S., age 59, married. Present trouble began in January, 1912. First began to be troubled with a frequency of urination, accompanied by considerable distress. Her symptoms increased in severity, and in October the patient was compelled to take to her bed. About this time she noticed blood passing with the urine, for the first time. She was then voiding urine every five to fifteen minutes. On January 15, 1913, cystoscopic examination showed a large rather elongated villous tumor, located back of the left ureter. Patient received fifteen fulguration treatments. Tumor entirely disappeared, together with all symptoms. In June, 1916, a small recurrence was discovered, which yielded to treatment in three sittings. On November 20th, cystoscopic examination showed bladder clear of all growths. A small villous tumor was discovered at the external meatus. This was incised and the base cauterized.

Transvesical section. At this time a question exists as to whether or not the bladder should be opened in all cases of vesical tumor not amenable to fulguration. The excellent results reported by Pfahler, of Philadelphia, and others by the use of massive roentgentherapy in carcinoma located in other parts of the body; and the encouraging report of cases treated by Barringer of New York, with radium, in inoperable vesical carcinoma, demand consideration.

Whether or not massive roentgentherapy, or the use of radium shall be given precedence over resection of malignant growths located in the trigone, or extensively involving other parts of the bladder, experience must decide.

Of the several routes of entering the bladder in vogue at one time or another, all except the suprapubic have been discarded as obsolete by most operators. When opening the bladder suprapubically for the purpose of resecting a vesical tumor, the question naturally arises as to whether or not the peritoneal cavity must be entered. In practically all cases demanding cystotomy for tumor, infection is present, and while numerous cases are on record where the bladder contents have entered the peritoneal cavity without untoward results, extraperitoneal section is to be preferred whenever possible. However, in cases of extensive involvement of the superior and posterior walls of the bladder, in cases where the peritoneum cannot be readily stripped off, it is advisable to boldly enter the peritoneal cavity, and resect such portion of the vesical wall as may be necessary for the removal of the growth. Before attempting to strip off the peritoneum, the urachus should be divided and the cut ends cauterized, as this rudimentary organ is sometimes patent and may be a possible inhabitant of infective organisms.

Before being opened, the bladder should be cleansed with some antiseptic solution, and filled with air. The air is preferable to fluid distention as only the urine secreted during the operation has to be cared for, and the possibility of infective fluid entering the prevesical space or the peritoneal cavity, is greatly lessened.

All tumors of the bladder are prone to recur. A marked tendency exists for recurrences to appear at the sites of incisions. Keys has recommended stitching the bladder walls to the skin, after opening, before interfering with the tumor. After the bladder has been exposed, the operator must select the technique which seems indicated by the character of his findings, having already informed himself as to the nature and extent of the involvement.

Small pedunculated non-infiltrating tumors, can be readily grasped and separated from the pedicle, and the base and a few centimeters of the adjacent bladder wall fulgurated, or the base and pedicle can be removed with the cautery knife. Great care should be exercised in removing the tumor, to see that it does not come in contact with the edges of the wound. In dealing with a large papilloma, it may be almost impossible to extract the tumor from the bladder, without coming in contact with the edges of the suprapubic wound. For this reason it is well to cauterize all wound edges before closing.

A tumor with a hard infiltrating base, demands wide resection of the entire bladder wall. Beer has described an excellent technique in these cases, by entirely stripping the peritoneum from the bladder, and incising the wall about the tumor, from without inward. The resection should best be done with the cautery knife, whenever possible. The wound should be closed by catgut sutures internally, and reinforced with silk or linen externally.

When the tumor is located near, or involves the ureteral orifice, it will be necessary to resect and implant the ureter. Catheterizing the ureter before commencing the resection, greatly facilitates the work.

As implantations on wound edges are common, and as one cannot be certain that this has not occurred during the operation, some method of prevention should be employed. For this reason the cautery knife should be used for resection whenever possible and all wound edges should be cauterized before closing. Burnam of Baltimore has suggested flushing the bladder with alcohol before closing.

CONCLUSIONS

1. That every patient suffering from hæmaturia should be referred to the urologist for an early diagnosis.

2. That, when found to be present, all vesicle tumors should be eradicated.

3. That all cases of untreated vesicle tumor terminate fatally.

4. Method of choice. That all tumors of the bladder whether benign or malignant, pedunculated or sessile, should be subjected to the high-frequency current.

5. That all tumors not amenable to the high-frequency current should be removed by transvesical section.

6. That massive roentgentherapy and possibly radium, should be combined with high-frequency and transvesical section.

CONGENITAL RECTOVAGINAL FISTULA

A New Operation for Its Cure

CARYL A. POTTER, M.D., St. Joseph, Missouri

ANOMALIES causing incontinence of fæces or any impairment of the normal function of the rectum are held in abhorrence by the laity, and the medical profession dreads above all things fæcal fistulæ, whether they are inevitable postoperative sequences or purposely made by the surgeon. Consider then the discomfort and mortification which would come to a woman with a congenital rectovaginal fistula who had only known fæcal incontinence since birth. Such a patient was the following:

S. L., age 26, was referred to me with the following history: Since birth nothing had passed through the external anal orifice, but there had been a constant leakage of fæcal matter through the vagina. She had constantly worn a pad to keep from soiling her clothes.

Every precaution was necessary to prevent her body from emitting a fæcal odor, and constant changing and care were necessary if she allowed herself the company of other people. After she commenced to menstruate the mixture of fæcal matter and menstrual fluid made the condition more abhorrent and when I saw her she was not only a care to herself but a care to those about her. She had been examined on several occasions but had been given little encouragement for relief.

A cursory examination only partly revealed the existing condition. In order to elucidate the true character of the malformation an ether examination was advised with the possibility of a concurrent operation. The existing condition is shown in Figure 1.

The strength of the external sphincter ani which guarded the external orifice of the anal canal was especially noticeable.

After a thorough examination I satisfied myself with dilatation of the rudimentary anus and rectum but attempted no operation. Before the patient returned home she was given a dose of castor oil, the vaginal outlet plugged and, when she felt inclined to a bowel movement, instructed to strain. She noticed a small amount of fæcal matter pass from the rudimentary anus under control. She was sent home and instructed to close the vaginal outlet with gauze instead of wearing a pad and to take plenty of liquid albolene, prunes, and figs to see if the rudimentary anus would prove serviceable. She wrote that the dilatation had helped considerably but suggested that some sort of an apparatus could possibly be made to close the vaginal outlet. I was considering the construction of one when she wrote again saying that the rudimentary rectum and anus were not functionating so well as formerly and she suggested that she return for another dilatation. It was proposed that she return for an operation which might result in a permanent or partial cure. A plan I had in mind at the time was an operation to close the vagina entirely and a plastic operation on the rectovaginal opening and rudimentary anus, thus obliterating the vaginal outlet and giving her a common cloaca, similar to that of early embryonic and lower animal life. This would result in a common outlet through the rudimentary rectum and anus which would allow fæcal matter, and vaginal and uterine secretions to make exit through a common opening. As this would be controlled by the sphincter ani, it would be much preferable to a constant leakage through the vaginal outlet. On further consideration and study of the condition, it seemed not only possible but probable that an operation could be performed which would result in a separate vagina and rectum.

Investigation of the literature was futile. There is little if any mention of the condition, much less a description of its operative cure. A brief study of the embryology is interesting and explains the existing anomaly. According to Heisler:

The early stages in the development of the anus are similar to those of the mouth. The so-called anal membrane is produced by the growing together of the ectoderm and entoderm, the mesoderm being crowded aside. The side of the anal membrane, or anal plate, is in the median line of the dorsal surface of the embryonic body at its posterior, or caudal extremity. It makes its appearance the third week. Since the tissue immediately in front, i.e., headward of the anal plate projects and develops into the primitive tail and, since the axis of the body becomes ventrally curved, the anal plate is carried around somewhat toward the ventral aspect of the body. During the following fortnight the anal plate becomes depressed so as to form a small fossa which is designated the anal pit or proctodeum. The anal plate, in position, does not correspond, in vertebrates, to the end of the intestine but to a point short of it. The gut, therefore, extends beyond the position of the anus. This portion of the bowel is the postanal gut of vertebrate morphology. Ultimately it entirely disappears.

While the anal pit is forming the allantois is growing forth as a diverticulum from the ventral wall of gut.

The intra-embryonic part of the allantois is transformed chiefly into urinary bladder, but from its proximal extremity it gives rise to a short wide duct, the urogenital sinus, which is the avenue of communication with bowel. The surface depression referred to above as the anal pit is often called the cloacal depression, while a cloaca is present.

In the lowest mammals and monotremes, as also in amphibia, reptiles, and birds, the cloaca is a permanent structure. By breaking down of this membrane between it and the cloacal depression it acquires an outlet through which urine, fæces, and genital products find egress. In all higher mammals, however, including man, the cloaca suffers division into an anterior or ventral passageway, the urogenital sinus, and a posterior canal, the rectum and canal of the anus. This division is effected by the growth of three ridges or folds of which one grows from the point of union of the urogenital sinus and the gut, while the other two proceed, one from each lateral wall of the cloaca. The three folds coalesce to form a perfect septum. The division is complete about the end of the second month.

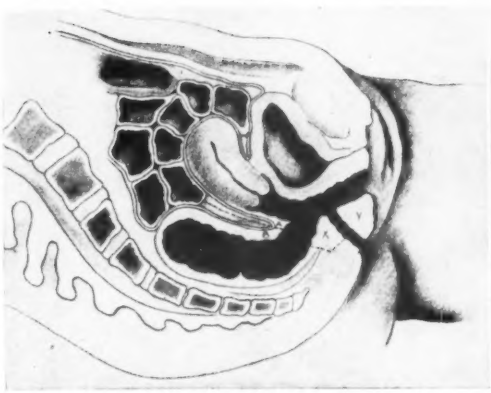

Fig. 1. Congenital rectovaginal fistula. *A*, Anterior flap of the split rectovaginal septum which formed part of the new vaginal floor; *B*, posterior flap of the split rectovaginal septum which formed the new anterior wall of the rectum; *X*, mount of tissue removed by diamond-shaped incision indicated by dotted line. On being sewed longitudinally this helped to flatten out and form the new posterior rectal wall. *Y*, Perineal body. Rudimentary anus is shown between *X* and *Y*. Dotted line between *A* and *B* indicates the line of incision to form the flaps for the poterior vaginal and anterior rectal walls.

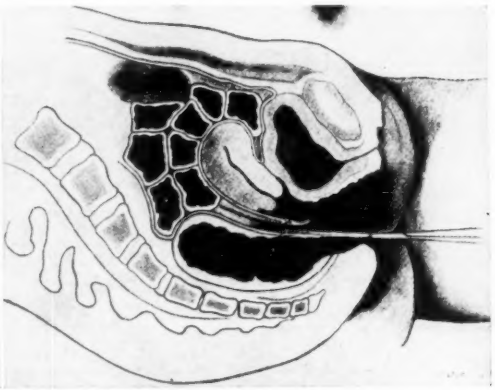

Fig. 2. This shows the rudimentary anus and vagina made a common opening by having split the perineal body; the posterior mound of tissue removed to flatten out the rectum and the posterior flap *B* of the split rectovaginal septum pulled forward to the sphincter to form the lumen for a new anal canal and rectum.

The cloacal depression or anal pit shares in this division so that about the tenth week it is separated into the anal pit proper or proctodeum, and the orifice of the urogenital sinus. The newly-formed septum continues to thicken. especially near the surface of the body, until it constitutes the pyramidal mass of tissue known as the perineal body or perineum.

The anal pit deepens, the anal membrane being thereby approximated to the end of the bowel, and in the fourth month the anal membrane breaks down and disappears. Persistence of the anal membrane after birth constitutes the anomaly known as imperforate anus.

The explanation of the formation of the condition shown in Figure 1 (congenital rectovaginal fistula) is readily seen from the embryological description above. The failure of the three ridges or folds to coalesce and form a perfect septum is responsible for a part of the condition.

Any one of these failing to grow across and meet the other would cause the defect, just as the failure of the anal membrane to break through would cause imperforate anus. Another look at the figure will explain the true condition of affairs. The urogenital fold has grown downward incompletely and the lateral folds have not entirely closed. The lower end of the septum has thickened to form a perfect perineum and the cloacal or anal pit growing in from the posterior end has formed a fairly good anus. It is, therefore, a defect due to failure of closure of the three ridges, principally the two lateral ones.

The following operation for the cure of the condition was planned and executed:

With a curved bistoury slipped entirely through the rudimentary anus and rectum into the vagina the anterior wall of the rudimentary anus and rectum (including the external sphincter and poorly developed internal sphincter) and the perineal body were split, thus making the rudimentary anus and vagina a common opening, the cut perineal body intervening between the mucous membrane of the rectum and the mucous membrane of the vagina. The split ends of the levator ani muscle and fascia were located and dissected free for future use. With a razor blade knife the anterior layer of rectovaginal septum was separated from the posterior layer, three-fourths of the distance to the cul-de-sac, giving an elastic membrane covered with vaginal mucous membrane anteriorly and another, covered with rectal mucous membrane, posteriorly. A diamond-shaped piece was taken out of the mound in the posterior rectal wall and longitudinal interrupted sutures of chromic 20 day No. 1 catgut placed so as to lengthen as well as to flatten the posterior surface in order to form the posterior wall of the new rectum and anus. On the posterior half of the split rectovaginal septum, i.e., the anterior wall of the true rectum, three Oschsner forceps were placed and drawn down by an assistant so that the anterior rectal wall would meet the cut ends of the sphincter ani. Not wishing to place too much tension on the anterior or vaginal half of the split septum two flaps with broad bases were dissected free from the lateral vaginal walls, so that on rotation they could be coaptated to the anterior or vaginal side of the split septum. These procedures are shown clearly in Figures 1 and 2.

With the assistant holding the posterior half of septum taut, sutures were passed through the levator ani muscle, fascia and septum. Additional interrupted sutures were placed through the levator alone to relieve tension on the sutures placed through muscles and septum. The lateral margins of the posterior layer of the septum were sutured to the rectal wall thus completing the new rectal lumen.

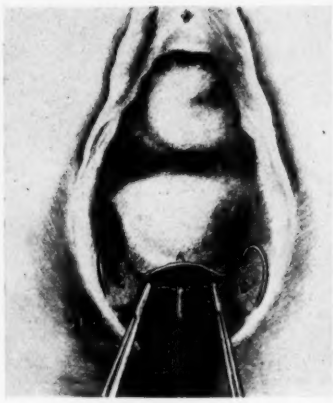

Fig. 3.

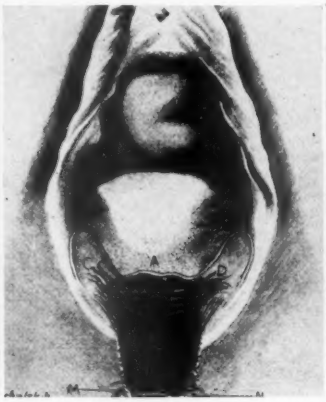

Fig. 4.

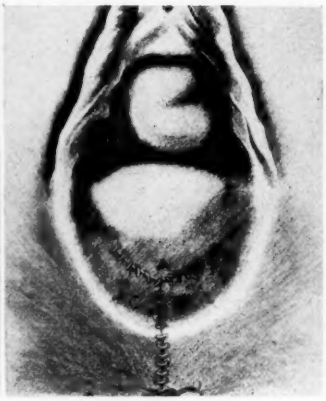

Fig. 5.

Fig. 3. The clamps have been placed on the posterior half of the split rectovaginal septum preparatory to drawing it forward (Fig. 2); the anterior half of the rectovaginal septum remains (A) free and flaps *C* and *D* have been dissected from the lateral vaginal walls. On being rotated and sewed to *A* they help form the vaginal floor.

Fig. 4. The levators are shown dissected free. Sutures have been placed through the levators and connective tissue of the new anterior rectal wall *B* which has been drawn forward and sewed to the mucous membrane of the old rudimentary anus. On drawing tight and tying these sutures, dead space was killed and a new pelvic floor formed. *M* and *N* indicate the cut ends of the sphincter ani.

Fig. 5. Shows the complete operation. *C* and *D* have been rotated and sutured to *A* to form the front portion of the new vaginal floor. The mucous membrane proximal to the vulva and bounding the raw surface left by the rotated flaps has been dissected back and sutured to *A*. The skin has been dissected back and is shown sutured across to form the skin of the new perineum. The line *MN* indicates the cut ends of the sphincter ani which have been dissected free and sewed to the skin edge allowing temporary incontinence but readily accessible for future union under local anæsthesia.

Both the muscle sutures and the muscle and septum sutures were simultaneously drawn tight and a new pelvic floor formed. The purpose in placing the sutures through muscle and septum was to distribute the tension over a wider area and kill dead space, by making the new anterior rectal wall hug the perineal body closely. Killing dead space is a fixed rule for successful plastic vaginal work. The foregoing steps are shown in Figure 3.

The next step was the rotation of the lateral vaginal wall flaps and the closure of the skin. These steps are shown in Figure 5.

Although everything was sewed solid it was felt that the whole procedure would probably be fruitless if tension were allowed to be made on the stitches. At the same time we were after ultimate rectal control. As I mentioned above the sphincter ani muscle was very strong but we had cut it in the original procedure. It was decided that more perfect solid union of the newly made structures would result if we gave the patient temporary incontinence. Therefore the external sphincter was left divided but the ends dissected free and stitched to the skin so as to be readily accessible for later union under a local anæsthetic.

Following operation the bowels were not moved for six days. On the sixth night 8 ounces of olive oil was injected into the new rectum, the walls of which were apparently intact. Castor oil was given, and in the morning at five o'clock another 6 ounces of olive oil injected into the rectum. The pads were solid with fæcal matter the morning of the seventh day. The field of operation was not examined until the twelfth day when the silkworm-gut sutures through the skin were removed. The pelvic floor was intact. and the new rectum and vagina were of sufficient size.

The patient was kept in bed three and one-half weeks and discharged from the hospital at the end of four weeks.

During this time several ounces of olive oil were injected into the rectum the morning of each alternate day. She was discharged at the end of the fourth week and instructed to return in four months so that the cut ends of the external sphincter could be united. I waited five months and then wrote her urging her to return. She replied that it was unnecessary to return as she could control her bowel movements altogether except when she took castor oil, and then there was only a slight leakage of liquid fæcal matter. Recent examination showed that the slight bridge which had been left between the cut ends of the external sphincter had been spanned by fibrous tissue. The sphincter control is good.

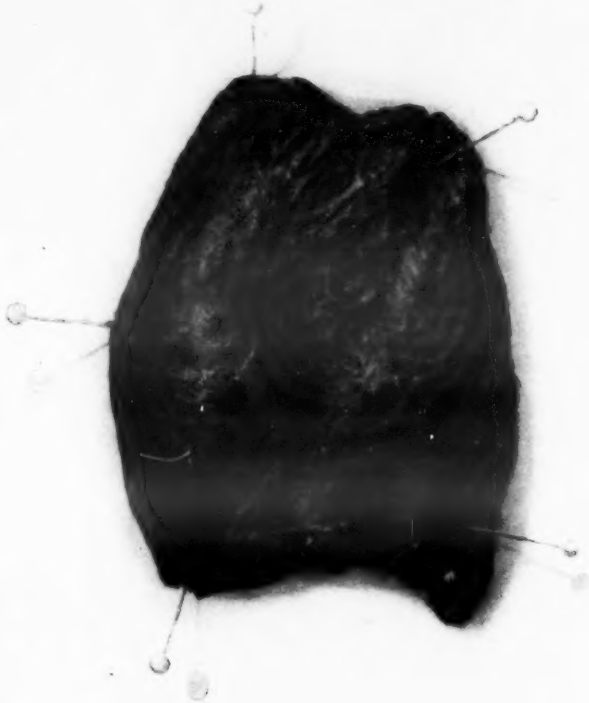

Fig. 1. Gangrenous cholecystitis due to gas bacillus infection. Internal surface.

Fig. 2. Gangrenous cholecystitis due to gas bacillus infection. External surface.

(Gangrenous Cholecystitis—Gilbert G. Cottam.)